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The Secondary Market for Enrichment Services

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To Our Readers

On October 21, 1983, Mr. J. R. Wolcott, Nuexco's chairman and chief executive officer testified before the Conservation and Power Subcommittee of the US House of Representatives Energy and Commerce Committee. The hearing dealt with the US Department of Energy (DOE) enrichment program, its goals and its strategy to achieve those goals. As the only witness invited from the commercial sector, Mr. Wolcott spoke on the secondary enrichment market. Part One of this Special Report presents Mr. Wolcott's testimony, slightly edited for this publication. Mr. Wolcott's prepared remarks are followed by his responses to questions posed by the subcommittee's chairman and its legal counsel.

Part Two of this Special Report presents excerpts from other testimony presented at the hearing. Although the other witnesses focused on the primary market and on DOE's overall program, those things are so influential over the secondary market that they are worthy of attention from anyone interested in the nuclear fuel market.

* * *

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PART ONE: WOLCOTT TESTIMONY

THE SECONDARY MARKET FOR ENRICHMENT SERVICES

by

J. R. Wolcott
Chairman, Nuexco

presented to
US House of Representatives
Energy and Commerce Committee
Energy Conservation and Power Subcommittee

October 21, 1983

Summary

1. Secondary markets have developed in the uranium fuel cycle out of users' needs to restore supply and demand balance. A secondary market consisting of user-to-user sales has become a permanent feature of the enrichment services (SWU) market.

2. Penetration into the US market by non-US enrichers is modest, presently a little over 10 percent of US users' needs, and probably would continue to be modest for several years if DOE took no retaliatory action. I know of no *long-term* contracts for non-US enrichment services having been placed to date in the USA, although the possibility exists.

3. Although DOE is competing with secondary market sellers, it operates under government and commercial constraints that make it difficult to compete in a constructive or effective way.

4. Even if DOE had the flexibility required to follow secondary market prices effectively, to do so would erode the primary market structure in which DOE will compete for the long term. The result would be substantial revenue losses.

5. Frustrating the secondary market interferes with the very mechanism that will correct users' imbalances and restore the long-term health of the primary SWU market. Pushing imbalances into the future will simply create more severe problems than now exist and delay the resolution of unhealthy market conditions that eventually must be corrected in any event.

Introduction

My name is J. Robert Wolcott. I am the Chairman and Chief Executive Officer of Nuexco, a professional services company specializing in the nuclear fuel market. Our business activities fall into three categories: brokerage, consulting and information dissemination.

1. Our primary vehicle for information dissemination, the Nuexco Monthly Report on the Nuclear Fuel Market, has approximately 400 domestic and international subscribers.

2. As consultants, we develop analyses of supply and demand, prices, strategies for procurement and marketing of nuclear fuel materials and services.

3. Finally, we are brokers of fuel cycle materials and services. We are not traders. We do not take principal positions for our own risk and account. Similarly, our standard fees are related to quantities of material transacted and not to the price of the transaction. From a business standpoint, we are indifferent to secondary market prices.

Nuexco has a large international involvement. More than half of our brokerage transactions involve at least one non-US party.

Headquarters are located in Menlo Park, California. Regional offices are located in Stamford, Connecticut, Atlanta, Georgia, and in France near Geneva, Switzerland. In addition, we have a network of twelve representatives and special consultants located in the most important regions of nuclear fuel users and suppliers.

My topic is the secondary market for enrichment services—what it is; why it exists; its impact upon primary market suppliers, especially DOE; and the impact DOE actions might have on the secondary market.

The Present Situation

At one time the USA was virtually the only commercial supplier of enrichment services, both to US and non-US customers. Primary market competition developed as Eurodif, Urenco, and Techsnabexport (USSR) began selling to DOE's non-US customers. Today DOE supplies about 35% of non-US needs.

When US utilities signed their present enrichment contracts, they had virtually no alternative to DOE (Exhibit 1 summarizes the terms and conditions of six types of USDOE enrichment contracts). DOE at first supplied virtually 100 percent of US customers' enrichment needs. Until recently, the secondary market consisted mainly of assignments of Adjustable Fixed Commitment (AFC) contracts from one DOE customer to another. Recently the secondary market has developed in such a way that European sellers now are supplying enrichment services and enriched product to US users. Some of the SWUs supplied by those European sellers to US buyers have been obtained under AFC contracts. A larger part is of Eurodif origin. However, DOE still supplies almost 90

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percent of US users' current needs. (Exhibit 2 discusses the development of the secondary SWU market in detail.)

US users are consuming non-DOE enrichment services purchased on the secondary market at an annual rate of approximately 12 percent of needs. Approximately the same rate will probably prevail in 1984 and 1985. No long-term commitments for the supply of Eurodif SWUs are known to have been made in the United States to date.

Several fundamental changes have taken place in the primary and secondary SWU markets over the past two years. Some of them constitute the proximate causes of DOE's aggressive efforts to maintain 100 percent of the US market. On the other hand, some of the changes have been brought about by DOE's actions against the secondary market participation by sellers of non-DOE SWUs.

1. For five years or more, DOE has been losing business in non-US markets, and particularly in Europe. Much of the loss has resulted from European clients' annoyance with the US non-proliferation policies instituted by President Carter. A related influence has been the desire on the part of DOE's European customers for self-sufficiency throughout the nuclear fuel cycle. For example, West German customers terminated a number of DOE contracts in favor of Techsnabexport (USSR) and Urenco. In other cases, European customers of DOE sold their DOE commitments to U.S. customers of DOE, usually replacing the buyers' corresponding DOE commitment.

2. Two years ago, before Eurodif enrichment services were being offered to the US market, DOE had no domestic competition. Once European SWUs began to penetrate the US market, DOE became concerned about the loss of its domestic market, and has reacted with efforts aimed at maintaining 100 percent of the US market. DOE has taken four notable actions with those objectives in mind.

a. By holding SWU prices at their current levels when the latest price determination was made earlier this year, DOE interrupted a string of SWU price increases dating back ten years.

b. The Interim Sales Contract (ISC), sometimes called the mini-deal, offers holders of requirements contracts having 3.5-year termination provisions the opportunity to pay the lower AFC price for SWUs, in exchange for which they would agree not to terminate SWU deliveries for FY83-85. (Exhibit 4 discusses in more detail the secondary market impact of the ISC.)

c. DOE is proposing the Utility Services enrichment contract (USEC), the exact terms and conditions of which have not yet been revealed. The forerunner to the USEC, known as the Facility Requirements (FR) contract, was issued in draft form more than a year ago. (Exhibit 5 discusses in more detail the secondary market impact of the draft FR contract.) Preliminary comments from DOE and from utility executives who have been invited to review the current version indicate that the USEC will give DOE clients more favorable terms and conditions in exchange for the surrender of their rights to use non-US enrichment services. (Exhibit 9 discusses Nuexco's analysis of the likely market response to the USEC.)

d. DOE has most recently offered to holders of 3.5-year Requirements contracts a modified ISC, which gives the customer freedom to substitute *at no charge* SWUs obtained on the secondary markets for up to 40 percent of requirements for FY84 and up to 60 percent of requirements for FY85, but *only* by using DOE SWUs. In exchange, the customer must agree in principle to accept the USEC when issued if it is at least as advantageous to the customer as the present 3.5-year Requirements contract. (The effect of DOE's offer of the modified ISC is discussed in more detail in Exhibit 7.)

3. Non-DOE suppliers of enrichment services have large excess capacity and are competing vigorously for the available market. Moreover, the USA is adding capacity and Japan is planning to do so. National nuclear power programs continue to fall well short of planned levels, so there is no possibility that the world's enrichment capacity could be fully utilized during this century. If DOE succeeds in retaining the US market, it will do so at the expense of Urenco, Eurodif and Techsnabexport.

Competition in worldwide SWU markets, and especially in the US market, has become a central concern of the enrichment services industry. A secondary market has developed with prices well below those the Department of Energy (DOE) charges primary customers. Utilities have, accordingly, encountered a new situation. The secondary market provides competitive choices—something utilities have not previously had. Enriched uranium and/or SWUs can be purchased from both other US utilities and from non-US sources. As serving the consumer is a paramount concern, choices have to take account of economic opportunities, and those favor secondary market purchases.

A major problem, from DOE's point of view, are the numerous constraints which greatly inhibit its ability to adapt to market realities in a beneficial way. I will discuss those later. .

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Secondary Market Causes, Nature and Responses

Worldwide SWU production capacity is at least double that needed to accommodate consumption. Coping with this situation obviously requires considerations of causes, effects, and long-term solutions rather than mere temporary fixes. At first all suppliers had been reluctant to revise their approach. However, non-US enrichers have begun to compete vigorously for sales in the primary market.

The secondary market consists of trading between users. A user may have an excess of inventory or uneconomical future commitments. Relief is needed. There is a price at which a certain class of buyers will find it more economical to utilize SWU from the secondary market than to take delivery under a primary supplier contract. Note that the secondary market arises out of a need for relief. Competition is not the same as that which exists between primary sellers.

In the US, the secondary market for enrichment services has been around since the mid-1970s, and it has developed because past production has been excessive. For years, it was characterized by assignments of excess commitments and the exploitation of various termination provisions in DOE's enrichment contracts. Only in the last two years has distress selling of excess inventories brought competition in the form of non-DOE origin SWUs into the US market. (Exhibit 8 discusses in more detail the sources of secondary market SWU supply and demand.)

Enrichment services transactions fall into two broad categories.

1. In a **SWU sale,** uranium in enriched form (called "enriched product") may be sold for cash. Enriched uranium may also be exchanged for an equivalent amount of natural uranium and cash sufficient to cover the associated enrichment services. Other combinations of SWUs and cash are possible in this type of transaction, which is called a deenrichment swap.

2. In a **SWU assignment,** contract obligations may be reassigned from one user client to another.

The most important difference between a SWU sale and a SWU assignment is that the latter requires DOE consent and the former does not.

Pricing in the Secondary Market

As in any market, secondary market pricing is ultimately determined by matching value to the seller and value to the buyer. But the SWU market does have some special conditions which play a dominant role in the matching of these values.

Strong driving forces may exist on the seller side. For example, a seller may have an inventory of utterly unnecessary enriched product, as in the cases of some utilities whose only reactors have been cancelled. Or the seller may have future contractual commitments that would be prohibitively expensive to terminate. Users are sometimes forced to purchase otherwise unneeded natural uranium to supply enrichment services contracts, even though those may only further aggravate an enriched uranium inventory problem. As uranium is a single purpose commodity, nuclear power utilities are the only end users. Thus, a seller must adjust prices to whatever that one class of customers will pay.

Not all secondary market SWU sellers have strong driving forces. However, those that need relief the most tend to be the most aggressive, and thus the price leaders.

Buyers' problems are simply economics. All nuclear power plant operators are covered by long-term contracts with primary suppliers. Those that buy on the secondary market do not do so out of concern for the availability of a primary source. Rather, they participate in the secondary market only because opportunities in that market are economically attractive.

Conditions in the USA are such that a SWU seller must offer a price that offsets the buyers' termination fee under DOE contracts and, in addition, justifies the cost of participating in a special transaction. Where non-US SWU sources are involved utility buyers may require additional incentives "to go offshore."

These considerations have resulted in sellers (European *and* US) offering DOE SWU in the United States at prices of approximately $95 per SWU for short-term delivery. Non-DOE SWUs are approximately $90. [*Ed. note: those prices have since changed to $85 for non-DOE origin and $115 for DOE origin, due to the effect of DOE's modified Interim Sales Contract, explained in detail in Exhibit 7.*]

I would like to emphasize for your consideration the manner in which secondary market SWU prices are locked into DOE primary market pricing formulas. Primary market system changes immediately reflect back into secondary market pricing. The same incentives have to be maintained to keep the secondary market viable. An example of this interlocking relationship was recently demonstrated as a result of DOE's July 25, 1983 offer of the ISC. The offer included a price concession of approximately $11 to 3.5-year Requirements Contract holders. Secondary seller prices dropped about the same amount in order to maintain a realistic market position.

Note that DOE's pricing strategy has to be carefully

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considered because of other, possibly unwanted effects. A secondary market price of $90 places prices near a threshold where 5-year Requirements Contract holders may find it economical to participate in the secondary market. Thus far buying activity has been dominated by 3.5-year contract holders; but lower prices may expand that into the 5-year contracts.

Primary Versus Secondary Market Pricing

Although a direct relationship exists between primary and secondary market pricing, it is important to recognize that the two pricing systems develop from different starting points. Each primary supplier—DOE, Eurodif, Urenco and Techsnabexport (of the USSR) has its own unique pricing formula. Cost, nationality, return on investment, accounting practices, currency exchange rates and other variables play a role. A primary market share will be only partially determined by price.

Moreover, for primary producers, changing prices as a reaction to secondary market conditions is a risky course. As a primary supplier offers more favorable terms to match secondary market conditions, the secondary market then adjusts accordingly to maintain viability. A self-defeating cycle sets in—like a dog chasing its tail.

For example, the possible removal of imputed interest from the cost recovery formula has recently been publicized. As that is reported to be approximately $35 per SWU, and deliveries even at current rates are of the order of 15 million SWUs per year, loss of revenue will be on the order of one-half billion dollars per year. The prices of all non-DOE SWUs used in the US the next few years will only total around $200 million, or less than half the revenue loss. Moreover, the loss of revenue from omission of imputed interest may go on for many years while the secondary market loss may be relatively short-term. This is one example of how and why overreaction to the secondary market may be costly. The recently modified Interim Sales Contract, discussed in Exhibit 7, constitutes another example.

DOE's Commercial Constraints

Several important constraints limit DOE's responsiveness to the competitive environment prevailing in the primary and the secondary SWU markets.

1. *Cost recovery formula*—DOE is required by law to recover full costs over a reasonable period of time. This means, in effect, that pricing is a "zero-sum game". Any loss of revenue, whether from termination fees, or lower prices, to one class of contract holders, eventually must be recovered from price increases to other classes of contract holders. Therefore, DOE price concessions to 3.5-year requirements contract holders can best be regarded as a redistribution of cost to the industry as a whole rather than a selective price decrease. (At present, DOE uses a 10-year rolling forecast as a reasonable cost recovery period.)

2. *Price inelasticity of demand*—The primary market demand for enrichment services is virtually price-inelastic. Lower primary market prices do not significantly shrink the market. Increasing market share by one supplier must result in loss of market share by a competitive supplier. Moreover, price reductions by one primary supplier are usually met by other suppliers' price reductions as each attempts to maintain its share. The SWU market is essentially a "zero-sum market". That, coupled with the zero-sum cost recovery problem, makes for difficult pricing strategies.

3. *National policy consistency*—United States policy generally favors free international trade, more competition and less monopoly, and strong adherence to anti-trust principles. Inhibiting importation of SWUs would conflict with free trade. Limiting clients to DOE supply strengthens monopoly. Constraint of trade by contract contradicts anti-trust principles. Even though DOE is a government operation, and thus exempt from laws governing private companies, these actions provoke a negative reaction from those in industry who believe actions by government businesses should not run counter to government policy. The anti-trust, anti-monopoly philosophy is deeply ingrained in the underlying business ethic.

4. *Utility cost accountability*—Authority for spending and accountability for costs result in a split of responsibilities. Government, that is the Congress and Administration, determine expenditures, technologies used, and accounting practices. Utilities, on the other hand, bear the ultimate cost of those decisions. Utilities have, therefore, a natural reluctance to accept conditions which leave no option other than total dependency on DOE. The secondary market is a limited option, but at least it is some option. It is a means of requiring economic discipline by DOE not otherwise available to utilities.

The Apparent Thrust of Recent DOE Policy in Response to Secondary Market Competition, and Probable Market Reactions

I have discussed at length market conditions and constraints. I will next discuss what appear to me to be the thrusts of DOE's competitive responses and how the market may react.

The *first* is to make price (the ISC and the modified

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ISC) and termination cost concessions (USEC) to selected classes of contract holders to bind them to DOE supply. Or looking at it another way, to eliminate competition from sources of non-DOE SWUs, both in the primary and secondary markets. Success will probably be limited for reasons suggested earlier—namely reluctance to forego competition and recognition that price concessions to one class of customer must be compensated by price increases to others.

The *second* is to restrict or eliminate imports of non-DOE SWUs. One part of that approach makes the price concessions conditional on customers' agreement to confine their secondary market purchases to DOE SWUs. Another part limits the proportions of DOE SWUs which may be purchased from the secondary market. The utility response will probably be mixed. An allegiance to DOE will cause some customers to accept that condition, since they would purchase only from DOE in any event. But other customers are concerned with what they regard as measures to lock them more securely to monopoly supply.

A *third* is to allow freer secondary trading of DOE SWUs by waiving termination penalties if SWUs ordered under one type of contract were replaced by DOE SWUs—but not for non-DOE SWUs. A probable consequence is an immediate rise in the price for DOE secondary market SWUs. Sellers would no longer have to price low enough to cover the buyers' previous termination cost. Much of what was formerly a penalty payment to DOE would go as a higher price to a secondary seller. The buyer could afford to pay more and maintain the incentive margin. DOE sellers would have more interest in selling. And, as buyers would not be burdened with larger termination penalties, they would be more interested in seeking offers. The net effect would be:

1. An increase in secondary market activity for DOE SWUs;
2. A two-tier pricing system under which DOE SWUs would sell at one price level and non-DOE SWUs at a much lower price level.

Future of the Secondary Market

Secondary markets develop with all commodities, as the devices by which excesses and deficiencies are brought into balance. A secondary market for excess enrichment services is not likely to be a short-term phenomenon.

A secondary market thrives on complexity. The greater the number of participants and the greater the number of contract types, the greater the incentives for doing something and the greater the number of interesting combinations that can be developed.

I have worked with the nuclear power utility business from its inception. Serving the consumer at the lowest practical cost has always been a major concern of utilities. But the events of the past few years have intensified that concern. Nuclear fuel buyers and managers are more aggressive than ever in seeking out situations which will result in lower electricity costs. The underlying DOE approach of inducing utilities to forego competition in return for price concessions obviously poses important policy questions for utility managers, Boards of Directors, and Public Utility Commissions. The crux of the matter is the question of short-term incentives for staying with DOE vs. the long-term risk of higher prices from a sole-source supplier. (Exhibit 6 raises a number of issues concerning future SWU prices.)

Much of the imbalance which has created the secondary market has only been slightly relieved; the numbers of possible contractual combinations appear to be increasing; and utility participants are making aggressive efforts to achieve cost savings. I foresee, as a consequence, a secondary market continuing for years.

Conclusions and Suggestions

The secondary market is a result of imbalance in the nuclear fuel supply industry. A secondary market is a symptom, not a cause. A primary supplier aiming to stifle the secondary market will, if successful, only defer and increase imbalances. Those must then be dealt with at some time in the future when the problem has grown even larger, and therefore with severe consequences. It is far better to relieve stresses as they occur rather than to force their accumulation. One seldom gains by insisting on more of the medicine that first made the patient ill.

At present, sales of non-DOE SWUs on the secondary market are claiming only about 12% of US users' enrichment needs. A similar proportion is probable for the next few years. A built-in buffer exists discouraging a major enlargement. The most vulnerable contracts, the 3.5-year Requirements contracts, are limited. Penetrating the next most vulnerable class, the 5-year Requirements contract, is more difficult because termination penalties are higher. And beyond that are the most difficult of all, Adjustable Fixed-Commitment contracts. The secondary market has to confront that self-limiting feature.

A certain stratification exists with utility buyers. Some view their primary responsibility as one of economics, whether that means domestic or foreign buying. Others are committed to domestic buying regardless of other op-

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tions. Those buyers will always be the first to accept an offer of concessions on price, terms, and conditions in return for stronger dependence on DOE supply. Those concessions would entail substantial cost to DOE, but very little cost to the utility already firmly committed to domestic supply.

The real target of DOE is the client willing to buy from non-US sources. Terms are designed to bring him under tighter control. If the incentives offered are less than needed to attract that client, DOE may suffer a net loss. The already-committed client will have accepted the preferred concessions, but the uncommitted clients may remain uncommitted, and thus, open to secondary market purchases. The net result may be a loss to DOE.

In my view--one more shaped by commercial than government experience--DOE's overriding competitive concern should be with the competition from other *primary* suppliers. And conversely, those competitive primary producers should be most concerned with competition from DOE. The secondary market is a rapidly moving target. Primary suppliers attempting to follow that relatively small but short-cycle market will erode the basic price structure for the larger, more important, long-term primary market.

The secondary market will continue to be driven by the need to sell excessive primary production. In addition to already existing inventories, already contracted supplies worldwide will outstrip consumption by 16 million SWUs over the next 5 years and by 6 million SWUs in 1983 alone. This will create the need to transfer some 3 million SWUs per year through the secondary market unless existing contracts are rationalized and production is curtailed. While most of the excess supply will be delivered to utilities outside the USA, US utilities already hold enriched uranium inventories representing a *surplus* of more than 5 million SWUs.

Unfettered, the secondary market will correct imbalances as they occur. A strategy designed to hinder the functioning of the secondary market hinders exactly that free market mechanism which is solving the fundamental problem. Ultimately, the primary supplier that best serves the interests of users while maintaining financial health will weather the competition best.

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EXHIBIT ONE

SUMMARY OF DOE SWU CONTRACTS

This article reviews the principal terms and conditions of six types of US Department of Energy (DOE) enrichment services contracts.

1. Requirements (two types);
2. Short-Term Fixed-Commitment (STFC);
3. Adjustable Fixed-Commmitment (AFC);
4. Draft Facility Requirements (FR);
5. Interim Sales (ISC).

Requirements Contracts

Requirements contracts, offered between 1968 and 1972, were the first so-called toll enrichment contracts offered by the US Atomic Energy Commission (now DOE). Their name is derived from the option customers have to take only their actual enrichment requirements from DOE. From the customers' viewpoint, the requirements contract is the best contract form ever offered by DOE.

Covering enrichment needs for the lifetime of a reactor, all requirements contracts expire between 1988 and 2012. Under the terms of the contract, the customer agrees, at least in theory, to purchase from DOE all SWU requirements for the reactor covered by the contract. However, the contracts' provisions for termination without charge after a relatively short minimum rolling period (free termination) make the *effective term* either 3.5 or five years (less if termination charges are paid), much shorter than the theoretical *maximum term* of thirty years. At the end of the contract term, the customer is free to use SWUs of any origin.

The contract feature most important to the secondary market is that providing for *free termination*. For any given year beyond the minimum rolling period, a customer may partially terminate a requirements contract; that is, to specify a zero SWU requirement. The requirements contracts first offered by the AEC specified a minimum rolling period of 3.5 years, while the later form increased the period to five years. Thus, the two types of contracts are commonly called **5-year Requirements** and **3.5-year Requirements** contracts.

During the minimum rolling period, when free termination is precluded, the customer may terminate by paying charges specified in the contracts. *Termination charges* are assessed as a percentage of SWU contract price and vary according to the amount of advance notice given.

Upon contract execution (or at least six months before the year of first delivery), DOE and the customer must have agreed upon the estimated annual enrichment requirements over the life of the contract, as documented in an appendix to the contract. Those estimated requirements (Appendix A), cumulated to the year of delivery, constitute the quantity ceiling above which the customer does not have to take and DOE does not have to provide required enrichment services. Adjustments to Appendix A can be made later upon mutual agreement of both DOE and the customer. As a practical matter, DOE customarily allows downward adjustments in the Appendix A requirements if the customer can demonstrate that the adjusted amounts will cover anticipated requirements. Unapproved or late adjustments may be subject to charges for partial termination. If the number of SWUs must be increased—that is, if the reactor's requirements are greater than anticipated—DOE usually will agree to deliver the extra SWUs, provided that the necessary production capacity is available.

Every year, on January 1 for US customers and on November 1 for non-US customers, the contract holder must provide a *non-binding notice* of estimated annual SWU requirements for the minimum rolling period (5 or 3.5 subsequent years). Under current practices, DOE also asks that customers provide estimates of their requirements for five to ten subsequent years. As part of the annual non-binding notice, the customer will also provide an estimate of the number of SWUs in every month of the two subsequent years. While the information provided by the customer is not contractually binding, the notice must include proposed dates for deliveries, allowing at least 90 days between feed deliveries, and withdrawals for the corresponding SWU deliveries.

At least 180 days in advance of SWU withdrawal, the customer issues to DOE a *binding notice* of the final number of SWUs, assays of feed and enriched product, and feed product quantities for a specific delivery. (The maximum enriched product and minimum feed assays must be within the assays specified in the DOE Standard Table of Enriching Services.) This is called a "firm-up" statement in that the 180-day notice becomes binding and may only be eliminated by termination (at a substantial charge) prior to SWU withdrawal. The transaction tails assay under the DOE on 180 days notice. Requirements assay under the Requirements contract is 0.2 percent, subject to change by DOE on 180 days notice. (Requirements contracts do not offer the variable tails assay option.)

Table I shows the termination charges associated with various notice periods for the two different types of requirements contracts.

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Table 1

TERMINATION CHARGES UNDER REQUIREMENTS CONTRACTS
(Percent of SWU Price for Terminated SWUs)

Notice (years)	5-Year Requirements	3.5-year Requirements
0-1	40 percent	25 percent
1-2	40 percent	20 percent
2-3	40 percent	15 percent
3-3.5	40 percent	10 percent
3.5-5	40 percent	0 percent
over 5	0 percent	0 percent

Another important feature of the requirements contracts is the inclusion of a *price ceiling*. The price for SWUs under this type of contract may not exceed a base price adjusted for escalation in power and labor costs (.75 x Power Index + .25 x Labor Index). During the 1970s, it was not uncommon for the ceiling price to be lower than the full cost recovery price. However, for the past few years, the ceiling price has not been limiting.

Payment for the delivery of SWUs must be made within 30 days of the DOE invoice date. This term was extended to 60 days for those holders of 3.5-year requirements contracts that accept the ISC offer except for deliveries in August and September 1983. Requirements contract *prices* (currently $149.85 for both 5-year and 3.5-year contracts) have usually exceeded AFC contract prices, but there is no apparent relationship between them.

Fixed-Commitment Contracts

The first fixed-commitment contract offered by DOE was the **Long-term Fixed-commitment (LTFC)** contract. While a few such contracts still exist, the LTFC contract is no longer a significant factor in the market for enrichment services.

The **Short-term Fixed-commitment (STFC)** contract, offered for 10 months in 1974-75, was developed as a companion contract to the LTFC. Originally intended to allow fabricators to purchase small amounts of enrichment services, DOE later broadened its policy to allow the use of the STFC in all contracting situations unsuitable for a long-term contract. The STFC was subsequently used as the foundation for the Interim Sales Contract recently offered to 3.5-year Requirements contract holders.

The **Adjustable Fixed-commitment (AFC)** contract replaced the LTFC contract in the late 1970s. It was DOE's response to customers' pleas for relief from excessive enrichment obligations caused by cutbacks in their nuclear programs.

In late 1982, DOE released the draft of a new contract form, the **Facility Requirements (FR)** contract. The revised version, unissued as of this writing, is to be entitled the **Utility Services enrichment contract (USEC)**. Although reported to be completely different from the FR draft, it is more likely that the USEC will be similar in many respects when issued.

Numerous contract provisions are common to the STFC, AFC, and FR (draft) contract types.

1. The customer must define the proposed month(s) of delivery at least **314** days in advance. The customer may also request specific delivery dates within the delivery month(s).
2. DOE must notify the customer of the firm date(s) of delivery at least **240** (**275** in the FR draft) days prior to the beginning of the delivery month(s).
3. At least **180** days in advance of the firm SWU delivery date(s), the customer must specify the final quantities and assays (maximum enriched product and minimum feed assays to be within the assays specified in the DOE Standard Table of Enriching Services) of feed and product to be delivered.
4. A load-leveling provision allows DOE to alter delivery dates by up to two months, based on the values of three ratios calculated monthly. (The ratios relate to the distribution of DOE's scheduled SWU production over the six months preceding scheduled delivery.)
5. DOE may increase the 314, 240, and 180-day periods when the calculated ratios of monthly average demand exceed certain limits for an estimated month of delivery.
6. Feed deliveries to DOE must precede related SWU deliveries by 90 to 180 days as DOE may elect.
7. The price is the DOE fixed-commitment price in effect on the date of delivery.
8. Termination charges applicable to fixed-commitment type contracts are published in the Federal Register and revised periodically.

Termination Charges

The termination charges for fixed-commitment contracts (FC) are determined as percentages of the price of all terminated SWUs as of the date DOE received the termination notice. These percentages depend on the lead

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time given and the fiscal year the notice is given. These termination charges usually preclude secondary market purchases.

The termination charges for fixed-commitment contracts are reported in the Federal Register. Table 2 shows the charges reported in the notice dated November 28, 1980. A minimum charge is due, even if the number of SWUs affected by the termination of a given year's deliveries is zero. The minimum termination charge is equal to (0. 2 N P), where N is the number of years terminated and P is the sum of prepayments due or effected for each gross MWe of contracted plant capacity. For those contracts which required no prepayment, P is set at $3,300/MWe.

Table 2

TERMINATION CHARGES FOR DOE FIXED-COMMITMENT CONTRACTS

Advance Notice Period (Years)	Termination Charge (Percent of SWU Price) if notice is received in FY				
	83	84	85	86	87+
0.0- 0.5	51.5	47.5	43.2	38.6	33.5
0.5- 1.5	43.9	40.0	35.7	31.0	26.0
1.5- 2.5	36.9	33.0	28.6	24.0	19.0
2.5- 3.5	30.5	26.5	22.2	17.5	12.5
3.5- 4.5	24.5	20.5	16.2	11.5	6.5
4.5- 5.5	18.9	15.0	10.7	6.0	1.0
5.5- 6.5	13.8	9.9	5.6	0.9	0.0
6.5- 7.5	9.1	5.1	0.8	0.0	0.0
7.5- 8.5	4.7	0.6	0.0	0.0	0.0
8.5-10.5	0.7	0.0	0.0	0.0	0.0

STFC

The STFC contract is a short-term, take-and-pay contract. It must be executed no more than two years in advance of the DOE fiscal year of first delivery, but at least 180 days in advance of the month of first delivery. The STFC contract has a maximum term of 3 years, but may also be limited to just one SWU delivery, in which case the secondary market may be more advantageous. At time of execution, the customer and DOE agree on an enriching services schedule (Appendix A). This schedule defines the number of SWUs to be delivered in **each year** of the contract. At time of contract execution or at least six months prior to the fiscal year of first delivery, the customer must provide the estimated quantities of feed and assays of product (and notice of intention to use any enriched feed) to be delivered **each month** of the two subsequent years. This information is documented in another appendix (Appendix B), but is not contractually binding. Actual deliveries are firmed up by written notice 315 days in advance.

Adjustable Fixed-commitment (AFC) Contract

DOE introduced this type of contract in 1978 to replace the Long-Term Fixed-Commitment (LTFC) contract. The two contracts are essentially identical but for two major exceptions.

1. The rolling delivery period to be specified by the customer was reduced from 10 to 5 years.

2. Within the rolling period, DOE granted more flexibility with respect to the number of SWUs delivered in a given year and on the tails assay.

The AFC contract may be executed for a minimum period of 10 years and a maximum period to the lifetime of a reactor unit. Execution of the contract must be 6-10 years before the fiscal year of first delivery. An advance payment of $4,656 (possibly a different sum if a contract was executed after 1979) per estimated generated MWe is due in two installments. The first installment ($6000 per MWe) is due upon contract execution. The second installment (balance minus interest on first installment) is due 6 years prior to the first fiscal year of delivery. The prepayment accrues interest and is later applied against the first balance(s) due for the services provided. Additional payments, if any, are to be made within 30 days of the DOE invoice date.

Annual SWU requirements are firmed-up on a five year rolling period. Since the commitment for the fifth year is provided 15 months in advance of the first year of the five year rolling period, the contract actually contains six years of firm commitments documented in Appendix A. There are, however, some allowances for quantity flexibility. The fifth year of the rolling five year period is subject to +/-20 percent flexibility in the SWU commitment, and the fourth year is subject to +/-10 percent. Total quantity variation exercised for both years may not exceed +/-20 percent. The appendix also requires nonbinding estimates for the five years following the fifth year of the rolling period.

Included with its annual submissions, the customer must provide estimates of tails assays corresponding to the Appendix A SWU commitments. In addition, estimated *monthly* quantities and assays for the subsequent three-year period must be given.

As part of the AFC contract, the customer may elect the variable tails assay option (VTAO) at least 15 months

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prior to the fiscal year of withdrawal. The VTAO allows the selection of tails assays between 0.16 percent and 0.30 percent. DOE may assess an efficiency loss penalty for tails assays below 0.2 percent, but the penalty has never yet been applied. This information is contractually binding. (Exhibit 3 discusses the secondary market effect of the VTAO in some detail.)

The AFC contract contains two mechanisms by which a customer could obtain relief from excess SWU commitments. Prior to firming up the appendices, a customer could *delay* the initial delivery period (the first 5 years of commitments) as many times as needed for up to 5 cumulative years, paying one-fifth of the advance payment for each year delayed. Delay was the less expensive of the two mechanisms and was exercised by several utilities.

The second relief provision was the *deferral* option. Under this provision, upon 15 to 47 months advance notice, the customer can defer a delivery (and all succeeding deliveries) up to 5 years each time, as many times as needed. The charge for deferral is the difference in discounted cash flows resulting from the schedule adjustment. The discount rate to be used in the analysis is that in effect at the time of election as determined annually by DOE. The SWU price is the fixed-commitment price in effect at the time (currently $138.65).

Another important feature of the AFC contract is the substitution provision. When the customer specifies his SWU commitments for the fifth year of the rolling period, he may elect to reduce his requirements by the use of other DOE-enriched material (from his inventory or the secondary market). In effect, this option is available on a 6 1/4 year lead time. An active assignment market existed for several years as utilities reduced expected excess inventories through this mechanism.

Facility Requirements (FR) Contract (Draft Of August, 1982)

The draft Facilities Requirements (FR) contract offered DOE customers more flexibility, but at the cost of stronger penalties for contract terminations. DOE plans to release later this year a second version containing such drastic changes that it has been given a new name: the Utility Services Enrichment Contract (USEC).

The FR contract draft differed from the AFC contract in four important respects:

1. Reduced advance payments;
2. Shorter committed rolling period;
3. Heavier penalties for contract termination, such as full payment of estimated number of SWUs for a period of up to 10 years in the worst case.
4. Requirements could be reduced through substitution of material originally enriched by DOE (like that in the AFC contract) upon an advance notice of 30 months prior to the beginning of the year of delivery.

Interim Sales Contract

It had become possible for holders of 3.5-year Requirements contracts to achieve substantial savings by participating in the secondary SWU market. The mechanism used was the partial termination of the contract. Even after paying the DOE termination charges (10-25 percent of the contract price per SWU), these buyers could buy secondary market SWUs to replace their terminated DOE deliveries and save enough money to justify the effort. Following private negotiations with at least two utilities, and after some hesitations caused by legal and policy questions, DOE offered the Interim Sales Contract (ISC) to all holders of 3.5-year requirements contracts.

The ISC is essentially a STFC contract modified to reflect a special 60-day payment term and 180-day notice on quantities and assays of feed and enriched product. It offers any 3.5-year Requirements contract holder willing to waive the right to terminate and agree to take all FY83-85 SWU requirements from DOE a price reduction of approximately $11.20 per SWU. It reduces their price for FY83-85 from the Requirements contract price (currently $149.85) to the fixed-commitment contract price (currently $138.65). It also doubles the payment term from 30 days to 60 days (except for deliveries that took place in August and September 1983). Although no termination for FY83-85 SWUs is allowed after a DOE customer accepts the ISC, its net commercial effect has been to reduce the break-even price from $112.39 to $101.19, and correspondingly to reduce the secondary market SWU price.

EXHIBIT TWO

DEVELOPMENT OF THE SECONDARY SWU MARKET

Introduction

The secondary market for enrichment services has undergone a fundamental change during the past one to two years. From a limited market characterized by

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assignments of Fixed-Commitment contracts from one US DOE customer to another, it has begun to develop into a truly worldwide secondary market. During 1982, utilities began making use of the secondary SWU market as an integral part of their overall fuel procurement strategy, much as they have been using the spot uranium and conversion markets. Many have expressed hope that the secondary market will remain active for the long term.

Many of the factors driving this market are the same as those driving the U_3O_8 and conversion markets. Overoptimistic demand projections, contracting far in advance of need, reactor cancellations and deferrals, supply overcapacity, inventory accumulation, and high carrying costs combined to produce in many market participants, utilities, in this case, a strong desire to sell their excess inventories. This article will review how the secondary SWU market developed to this point, and comment on how this new market may be affected by future events.

Early Development of the Secondary SWU Market

It was the introduction of the AFC contract combined with DOE's reopening of the order books that first created an active secondary SWU market. DOE chose to provide contract relief to customers through liberalized schedule adjustment provisions when LTFC contracts were converted to the AFC form under the July 1, 1978 option. Some DOE Fixed-Commitment customers suddenly found themselves able to seek new supply for years when others less fortunate were still stuck with excess commitments. DOE's policy allowing customers to reduce the amount of SWUs taken directly from DOE by the same amount of DOE SWUs obtained on the secondary market was used extensively to the apparent advantage of both buyers and sellers as new schedules of commitments were drawn up. As reactor cancellations and deferrals increased the excess of SWU supply, new demand entered the market with the signing of new DOE contracts. Thus, some of the new contracts could be partially filled by assignments of other utilities' excess SWUs.

The discounts available for secondary market transactions (assignments from one holder of a US DOE fixed-commitment contract to another) during the 1978-1979 time period were in the range of $2 to $5 per SWU for all fiscal years. This would seem to indicate that the market supply and demand were approximately in balance. However, the level of discounts was misleading. The market was in its infancy, there was little market information available, and the level of sophistication among market participants was low. Almost all accepted the transactions that were brought to them without argument, apparently feeling that they would be unable to complete the required contracting and interface with DOE without outside assistance.

As the market has developed, market participants' increasing sophistication and the better information produced by open competition in the marketplace have reinforced one another. Discounts have become more representative of market factors, such as the amount of DOE termination charges and the balance of supply and demand, instead of being determined arbitrarily in the absence of adequate information.

The Variable Tails Assay Option (VTAO) also facilitated the development of the secondary SWU market. Falling U_3O_8 prices made the higher tails assays available under the VTAO more valuable than the 0.20 percent tails assays mandated under Requirements contracts.

The first signs of the factors which would be responsible for the sweeping changes in this market environment became evident by the beginning of 1980. By that time, most schedule adjustments and conversions to AFC contracts had already been completed. As the market for new reactor orders had virtually ground to a halt, very few new enrichment contracts were being signed. Thus, the demand for short term SWU dropped dramatically and the primary customers for assignments of US DOE AFC SWUs withdrew from the market.

In order to stimulate new demand, sellers increased the discounts they were offering. At the same time, the continual reactor construction delays fed more and more new short-term supply into the market. A number of short-term sellers, frustrated in their attempts to sell, eventually began actively soliciting buyers. A few short-term *buyers* who had become sophisticated enough to perceive their market advantage decided to seek supply through open bidding.

Those buyers were able to obtain discounts of more than $20 per SWU through such open bidding. These transactions were widely reported, and other buyers began demanding and receiving similar discounts. Since then, open bidding by buyers and sellers has become the rule in the secondary SWU markets, just as in the uranium and conversion markets.

Still, through 1980, the secondary SWU market was characterized almost completely by sales from one DOE fixed-commitment customer to another. It was far from a true spot market. During that period, standard utility practice called for buyers automatically to contract well

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in advance with DOE for enrichment services sufficient for the entire life of a planned project. Most buyers looked on the secondary market only as a tool to assist them with that function.

Many buyers soon found themselves reentering the market as sellers due to their having bought new long-term commitments on the secondary market for reactors that were soon thereafter delayed further or cancelled. Although contract assignments had helped to relieve the SWU supply-demand imbalance *temporarily*, the continuation of apparently conservative purchasing practices had caused the SWU supply-demand imbalance to worsen in the *long term*.

Development of the Market During 1981-1982

Continued reactor delays aggravated the short-term oversupply of SWU on the secondary market. The more open exchange of information in the secondary market enabled it to respond in classic fashion—prices dropped, in the form of discounts greater than $30 per SWU from DOE's AFC price. During 1981, the discounts reached a level that made it profitable for certain DOE customers (holders of DOE Requirements contracts having 3.5-year termination provisions) to terminate both short-term and long-term commitments and buy replacement DOE Fixed Commitment SWU on the secondary market.

At first, buyers were only willing to terminate after they had already found replacement SWU on the secondary market. Some buyers would try to terminate only a current delivery, in effect terminating their requirements contract on a year-to-year basis for a relatively small monetary gain. Other buyers terminated long term, in effect choosing to exchange the flexibility of the requirements contract for the increased savings made available by the fact that DOE termination charges decrease with time. Several distinct stages of market development were evident:

1. Near the end of 1981 and continuing into 1982, some of DOE's *overseas* customers holding requirements contracts with 3.5-year termination provisions began terminating some of their SWU requirements scheduled for delivery 18 to 24 months later and replacing them with attractively discounted SWUs from other sources, such as Eurodif or Techsnabexport.

2. Later in the year, some of DOE's *US* customers holding requirements contracts having 3.5-year termination provisions began terminating some of their SWU requirements scheduled for delivery 18 to 24 months later and replacing them with SWUs from LTFC or AFC contracts. In both this case and the previous one, sellers terminating their DOE SWU contracts acted simultaneously to effect any necessary replacement, so as to accept zero risk of supply.

3. The next phase in the development of the secondary SWU market saw both US and overseas DOE customers holding requirements with 3.5-year termination provisions begin terminating their DOE commitments with very short notice, 6-12 months, and replacing them with highly discounted AFC SWUs from another DOE customer. As sellers of excess AFC SWUs had filled demand from potential buyers who were willing to terminate their requirements contracts with relatively long notice periods, and the correspondingly modest termination charges, the selling had become more difficult. In order to stimulate more demand, those same sellers raised discount levels even further. The highest discounts enabled buyers to execute a risk-free transaction and still make a profit, even after paying the higher termination charges associated with short notice.

4. Eventually, however, and importantly for the development of the market, in 1982 a number of US buyers, having done such a transaction once or twice, became willing to terminate DOE requirements contracts to contract for replacement SWUs only when their actual requirements become known, counting on the secondary market as a later source of supply.

Meanwhile, European buyers' enriched uranium inventories were continuing to increase due to contractual overcommitments to primary suppliers in Europe, which were almost three times actual expected reactor requirements of the customer utilities. European sellers began approaching US DOE customers, but initially with no success. There was still a large amount of DOE SWUs available on the market, although at a slightly lower discount, and taking foreign SWUs was initially perceived by US utilities to be too great a risk.

By the end of 1982, however, the flood of new Requirements contracts buyers had used up almost all available DOE secondary market SWUs for short-term delivery at high discounts. There were not enough secondary market DOE SWUs available to meet the demand for those Requirements contracts holders who had not yet terminated 1983 deliveries and wished to do so. The attempts to sell Eurodif SWUs in the US began to meet with some success. Buyers either had to stay with the Requirements contracts, or purchase non-DOE SWU. A number made the decision to purchase foreign SWUs.

The new DOE Facility Requirements (FR) contract, introduced during 1982, is the largest uncertainty in the secondary SWU market. Termination charges under the FR have been designed to be prohibitive, so that wholesale conversion to the FR would virtually eliminate

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US DOE customers as potential buyers of non-DOE secondary market SWUs. However, DOE has not yet announced the terms and conditions of conversion to the FR, such as the range of schedule adjustments which will be allowed and the costs thereof. Those terms and conditions will help shape the future development of the market.

Future Development of the Market

The secondary SWU market is beginning to be viewed by at least some participants as a true spot market, another tool to be used along with long-term contracting as part of an overall strategy to minimize fuel costs. Whether the market will indeed develop to the point of being widely used for this purpose depends upon SWU supply for the long term remaining available on the secondary market.

Worldwide enrichment capacity will exceed expected reactor requirements far into the future. The critical question is whether this excess capacity will be translated into excess commitments that find their way to the secondary market.

The introduction by DOE of the FR contract constitutes the most serious threat to the long-term continuance of a strong secondary SWU market driven by excess DOE commitments. The FR contract's two-year rolling firm commitment period (as against the AFC contract's five years) indicates that, should most AFC customers convert as expected, the quantity of excess DOE SWUs available in the secondary market will diminish drastically. Some excess commitments will continue to exist due to unexpected reactor delays, but customers will not be faced with the possibility of building up years of unneeded inventory for a reactor that has not yet begun to operate. Therefore, the economic incentive to sell on the secondary market as against simply buying and holding inventory will be reduced substantially.

On the other hand, the continued buildup of enriched inventories in Europe, caused by the overcommitments of the various Eurodif partners, strongly implies that a large surplus of non-DOE SWU will become available for sale long-term on the secondary market. The vast majority of potential buyers remain the DOE 3.5-year Requirements contract holders. The vast majority of these DOE customers are in the US so they effectively dominate the buy side of the market. Conversely, European holders of excess SWUs will control the sell side of the market.

Whether the secondary SWU market remains active for the long term, as many active buyers hope, or instead proves to be a short-term anomaly, depends primarily on the acceptability of non-DOE SWUs to those same US buyers. At present, it appears that most US buyers, while still preferring DOE secondary market supply, would much rather take the perceived risk of buying foreign SWUs than give up the economic advantages of participating in the secondary market all together. The next significant market development could easily be the termination, both with short notice and longer term, of DOE requirements contracts and their replacement with non-DOE SWUs for the longer term.

EXHIBIT THREE

THE VARIABLE TAILS ASSAY OPTION: ITS SIGNIFICANCE TO THE SECONDARY SWU MARKET

Nuexco's brokerage experience indicates that the availability of the VTAO has encouraged the existence of an active secondary SWU market. The VTAO has had the following commercial effects:

1. It has effectively reduced the economic penalty of selling SWUs. Without the VTAO, some utilities having excess SWU commitments would decide simply to hold enriched uranium inventory. Having the option to vary their tails assay, those same utilities now find it economic to sell at the somewhat lower discounts necessary to complete a transaction at a higher tails assay.

2. It has enabled more utilities holding DOE requirements contracts to obtain the effective discounts necessary to terminate economically and buy replacement DOE SWUs on the secondary market.

An example will illustrate the use of the VTAO to facilitate a secondary market SWU transaction:

1. Utility A, wishing to dispose of excess SWU commitments, has elected a tails assay for its fiscal year 1983 (FY83) deliveries of 0.28 w/o (weight percent) under the VTAO.

2. Utility B, holding a 3.5-year termination Requirements contract, decides to terminate partially its minimum expected requirements for FY83 of 100,000 SWUs and buy the replacement SWUs from Utility A. Utility B pays DOE a termination charge of $37.46 for each SWU terminated (25 percent of the requirements contract price, $149.85 per SWU).

3. Utility B, just to break even, must therefore receive an effective SWU price of $112.39 per SWU ($149.85 - $37.46).

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4. In order to have some incentive to complete the transaction, Utility B decides it needs an additional discount of $3 per SWU, or a price of $109.39.

5. Therefore, if utility A were selling SWUs at a tails assay of 0.20 w/o, Utility A would need to offer a discount of $29.26 off the Adjustable Fixed Commitment (AFC) price per SWU ($138.65 - $109.39).

Since utility A is offering 0.28 w/o tails rather than .2 tails, however, the discount offered will be significantly less than $29.26, depending on the enriched product assay Utility B wants, as well as the marginal cost of UF_6 feed. *Note that Utility B's historical cost of feed does not affect the calculation, only the marginal cost of buying additional feed (in place of SWU) on the open market.*

Assuming that Utility B wants an enriched product assay of 3.4 percent, and that the marginal cost of feed in the spot market is $48 per KgU, the discount offered by Utility A could be calculated as follows:

1. Calculate the amount of enriched product Utility B wants, as well as the quantity of SWUs and natural feed required at .2 tails.

100,000 SWUs at .2 tails will produce 100,000/5.19 or 19,268 KgU as 3.4 percent enriched UF_6, and requires 19,268 x 6.26 or 120,618 KgU as natural UF_6 feed.

2. Calculate the quantity of SWUs and feed that would be required at .28 percent tails assay.

19,268 KgU at 3.4 percent enrichment with .28 tails requires 19,268 x 4.32 or 83,238 SWUs and 19,268 x 7.24 = 139,500 KgU feed.

3. Calculate the cost of 19,268 KgU at 3.4 percent enrichment with .2 w/o TA.

100,000 SWU x $109.39 per SWU ($138.65-$29.26) + 120,618 KgU feed x feed price ($48 per KgU feed) = *$16,728,664.00*

4. In order to calculate the SWU price (SP) at .28 TA that would be equivalent to a discount of $29.26 at .2 TA, set the cost of product at .2 TA equal to the cost of the *same amount* of product (19,268 KgU as UF_6) at .28 TA.

5. Thus, at .28 TA, the cost of 19,268 KgU as 3.4 percent enriched UF_6 would be calculated as

83,237 SWU x SP in $ per SWU +
139,500 KgU feed x feed price ($48 per KgU feed) = $16,728,664.00

6. Thus, 83,238xSP = $10,032,664
so, SP = *$120.53*

Solving for SP indicates that a price of $120.53 per SWU at .28 tails offered by Utility A will be effectively equivalent to a SWU price of $109.39 at .2 tails. So utility A only would need to offer a discount of $138.65 - $120.53, or $18.12 per SWU to complete this transaction.

EXHIBIT FOUR

INTERIM SALES CONTRACT: EFFECTS ON SECONDARY SWU MARKET PRICING AND DEMAND

Having discovered that some DOE customers (holders of Requirements contracts containing 3.5-year termination provisions) could save substantial amounts of money by partially terminating their DOE contracts, paying the DOE termination charges (10 to 25 percent, as opposed to 40 percent for contracts having 5-year termination provisions), and replacing those SWUs on the secondary market, DOE responded with the Interim Sales Contract (ISC) to induce them to forego the secondary market opportunity.

At a time when $1.8 billion already had been spent on the new Portsmouth centrifuge plant, DOE had lost about $1 billion worth of business through SWU contract terminations, and $470 million were still at risk over the next three years under contracts with nine customers. In the first of several tactics planned "to try and rationalize the market", DOE needed to offer prices which, given the current termination charges, would eliminate any significant incentive for a DOE customer to turn to the secondary market. Following negotiations with Philadelphia Electric Company and after some hesitations caused by the legal issues, DOE offered the ISC to all holders of Requirements contracts having 3.5-year termination provisions. Under the ISC, a DOE customer would waive the right to terminate the contract and would commit to take all enrichment requirements from DOE. In return, DOE would reduce that customer's SWU price for FY83-FY85 (currently $149.85) to the fixed-commitment contract price (currently 138.65) and increase their current 30-day payment term to 60 days.

The secondary market price for SWUs dropped by $8 as a direct consequence of DOE's offering of the ISC. With a 25 percent termination charge, currently $37.46, and a new secondary market price of $X, a utility willing to terminate a 3.5-year Requirements contract would end up paying $(37.46 + X) per SWU. Under the terms of the ISC, the same customer would pay only $138.65 per SWU (current fixed-commitment price). It is Nuexco's observation that, to give any utility some incentive to consider the secondary market, a profit of at least $6-7 should be possible. A mathematical translation of this statement is: (138.65) - (37.46 + X) must be greater than or equal to $6 to $7 or, X must be less than or equal to 138.65-37.46-($6 to $7) = $94.19 to $95.19. The inclusion of another $4-5 discount for SWUs of non-DOE origin

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would yield a secondary market price of approximately $90 for non-DOE SWUs.

The effect of the DOE's offer of the ISC has been to reduce the break-even price from $112.39 to $101.19, although no termination for FY83-85 SWUs will be allowed if the affected DOE customers decide to accept the ISC. Transactions unaffected by the ISC are all those that do not depend on a partial contract termination by a holder of a DOE Requirements contract having a 3.5-year termination provision. Those include:

1. DOE-origin/DOE-origin
2. Eurodif-origin/Eurodif-origin
3. Sales of DOE-origin SWUs to non-DOE customers.

Decisions by DOE customers holding Requirements contracts having 3.5-year termination provisions to accept or decline the ISC will be based on several factors.

1. By accepting the ISC, a customer would obtain a guaranteed saving ($11.20 per SWU for FY83, indeterminate for FY84 and FY85).

2. In exchange, that same customer would surrender the opportunity to obtain an even greater saving on the secondary market. Given the tremendous excess of secondary market SWUs, the course of action likely to yield the greatest benefit to shareholders and ratepayers is far from certain.

3. To the extent that a customer accepts the ISC in order to support DOE as their primary supplier of enrichment, that customer would be paying $6-$7 per SWU more than if they were bought on the secondary market.

The ISC's Impact on Secondary Market Demand

DOE's issuance of the Interim Sales Contract (ISC) lowered drastically the prices which sellers must offer to induce 3.5-year Requirements contract holders to terminate and buy replacement SWUs on the secondary market. The ISC could have caused secondary SWU market activities to come to a halt if it has been accepted widely by active buyers or if secondary market supply had diminished. However, sellers of large quantities of Eurodif SWUs, having no reactors in which to use their excess commitments, promptly lowered their offering prices in order to remain competitive.

As a result of sellers' lower offering prices, the demand for secondary market enrichment services for FY84 and FY85 delivery has returned to pre-ISC levls. Those 3.5-year requirements contract holders that signed the ISC, thereby withdrawing from the market, were in most cases not secondary market participants in the first place. The few formerly active secondary market buyers that have withdrawn had previously expressed strong interest in buying only DOE-origin SWUs. Thus, their withdrawal comes at the expense of those sellers of AFC SWUs (DOE-origin) that had been unwilling to offer the lower prices necessary to compete with the Eurodif suppliers.

DOE 3.5-year Requirement contracts cover 43 US reactors, 16 European reactors, and 8 Japanese reactors. A number of 3.5-year contracts had been partially terminated before the issuance of the ISC. Approximately 2 million SWUs for FY84 and 85 delivery had been terminated by US utilities, and 2.6 million SWUs for FY84 and 85 had been terminated by European utilities. Table 3 shows Nuexco's tabulation of estimated SWU requirements for those units still covered by the 3.5-year contracts at the time of issuance of the ISC.

Table 3

TOTAL SECONDARY MARKET POTENTIAL AT TIME OF ISSUANCE OF ISC
(thousands of SWUs)

	FY84	FY85
USA	2,240	1,330
Europe	150	120
Japan	540	550
TOTAL	2,930	2,000

The requirements summarized in Table 3 represent total potential secondary market demand from the 3.5-year requirements contract holders at the time of issuance of the ISC. Actual secondary market demand was less. A number of potential buyers have political or other institutional reasons not to terminate and buy replacement secondary market SWUs, particularly of non-DOE origin. Table 4 and Table 5 show Nuexco's estimate of the secondary market potential of US and non-US buyers respectively at the time DOE issued the ISC.

As of October 1, 1983, three US utilities representing demand for 880 thousand SWUs for FY84 delivery and 260 thousand SWUs for FY85 delivery have either signed or are in the process of signing the ISC. Likewise, the Japanese customers of DOE holding 3.5-year Requirements

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Table 4

SECONDARY MARKET POTENTIAL AT TIME OF ISSUANCE OF ISC: US UTILITIES WITH 3.5 YEAR CONTRACTS (Thousands of SWUs)

Utility	FY84	(Origin Sought)	FY 85	(Origin Sought)
A	130	(DOE only)	—	
B	160	(DOE or Eurodif)	150	(DOE or Eurodif)
C	770	(DOE or Eurodif)	560	(DOE or Eurodif)
D	150	(DOE or Eurodif)	—	
E	220	(DOE)	210	(DOE)
F	360	(None specified)	50	(None specified)
G	390	(None specified)	—	
H	—		160	(DOE or Eurodif)
I	—		140	(DOE or Eurodif)
J	60	(DOE or Eurodif)	60	(DOE or Eurodif)
Total US	2,240		1,330	

Table 5

SECONDARY MARKET POTENTIAL AT TIME OF ISSUANCE OF ISC: NON-US UTILITIES WITH 3.5 YEAR CONTRACTS (Thousands of SWUs)

Region	FY84	(Origin Sought)	FY85	(Origin Sought)
Europe	150	(DOE or Eurodif)	120	DOE or Eurodif
Japan	540	None	550	None

Table 6

SECONDARY MARKET POTENTIAL AS OF OCTOBER 1, 1983: US UTILITIES HAVING 3.5-YEAR CONTRACTS (Thousands of SWUs)

Utility	FY84	(Origin Sought) (or Current Status)	FY85	(Origin Sought) (or Current Status)
A	130	(DOE Only)	—	
B	160	(DOE or Eurodif)	150	(DOE or Eurodif)
C	640	(DOE or Eurodif)	560	(DOE or Eurodif)
D	150	(DOE or Eurodif)	—	
E	220	(DOE)	210	(Signed ISC)
F	360	(Signed ISC)	50	(Signed ISC)
G	390	(Will sign ISC)	—	
H	—	160	(DOE or Eurodif)	
I	—	140	(DOE or Eurodif)	
J	60	(DOE or Eurodif)	60	(DOE or Eurodif)
TOTAL US	2,240		1,330	

Table 7

SECONDARY MARKET POTENTIAL AS OF OCTOBER 1, 1983: NON-US UTILITIES WITH 3.5 YEAR CONTRACTS (Thousands of SWUs)

Region	FY84	(Origin Sought) (or Current Status)	FY85	(Origin Sought) (or Current Status)
Europe	150	(DOE or Eurodif)	120	(DOE or Eurodif)
Japan	540	(Expected to sign ISC)	550	

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contracts, representing 540 thousand SWUs for FY84 and 550 thousand SWU for FY85, reportedly intend to sign the ISC. No European utility has expressed interest in the ISC. Also, since the original offering of the ISC, one US utility terminated and bought on the secondary market 130 thousand SWUs for FY84. The current status is indicated in Tables 6 and7.

Only two US utilities that *previously had been in the market* decided to withdraw and sign the ISC. Their actions removed 130 thousand SWUs of FY84 demand and 260 thousand SWUs of FY85 demand from the secondary market for DOE SWUs. The remaining expected signees of the ISC had rejected previously the idea of terminating and buying replacement SWUs on the secondary market, despite the apparent economic advantages.

Potential buyers are continuing to participate actively in the market, confident that they will still be able to terminate their Requirements contract deliveries and buy on the secondary market from sellers of Eurodif-origin SWUs at a substantial economic advantage. Sellers of DOE origin SWUs also have been forced to drop their prices to compete.

EXHIBIT FIVE

THE IMPACT OF THE FR CONTRACT ON THE SECONDARY SWU MARKET

The driving force of the secondary SWU market has always been the need to dispose of excess DOE commitments. The long-term effects of the FR contract will therefore depend on the effect the new contract has on the amount of excess DOE SWU commitments. The short-term effects cannot be known until DOE announces the terms and conditions of conversion. The long-term effects, however, are apparent from a quick review of the contract's terms and conditions.

The FR contract contains a 2 year rolling firm commitment period rather than the 5 year period of the AFC contract. As a result, the amount of firm commitments made by customers to DOE will be drastically reduced. AFC customers, for example, were required on July 1, 1982, to specify firm commitments to DOE for FY 1988 if their contracts did not already contain such as part of an initial delivery period. Under the new FR contract, firm commitments for FY1988 in such a case would not have to be made until April 1, 1986.

If, as expected, most AFC customers choose to convert to the FR form, in the long run there will much less excess SWU that could be available for sale on the secondary market. Some excess commitments will continue to exist due to unexpected reactor startup delays and outages. But DOE customers will not be faced with the possibility of selling or possibly carrying unneeded inventory for 6 years or more. At most, a customer could be faced with 3 years of unneeded commitments. As a result, the economic attraction of selling as against buying and holding will be reduced. Therefore the discounts offered by potential sellers will be much less than at present.

On the demand side, the long-term effect of the FR contract will be to decrease secondary market activity. The FR contract states that DOE must be given 30 months notice if a customer is to reduce the amount of enrichment services taken from DOE directly by buying DOE SWUs on the secondary market. Under steady state conditions, there would be no FR contract holders with firm commitments that far ahead. Sellers would have to come from any remaining LTFC or AFC contract holders, or inventory holders who had not yet been able to sell material. Also, the attractiveness to the buyer of taking material on the secondary market is greatly reduced, since commitments to purchase on the secondary market would have to be made in advance of normal commitments made to DOE. It is questionable whether there would be any sellers offering discounts making it worthwhile for a secondary market buyer to accept this increased scheduling risk.

Requirements contract holders will most likely find discounts offered by DOE sellers to be too low to allow economic termination of Requirements contract deliveries and their replacement with secondary market SWUs. If such buyers are to continue their secondary market activity, they will most likely have to begin purchasing replacement SWUs from Eurodif sellers.

Under long-term equilibrium conditions following wholesale conversion to the FR contract, there would be little room for the existence of the traditional DOE customer-to-DOE customer secondary SWU market that exists today. Its most likely replacement will be a new secondary market driven by Eurodif excess SWU commitments, with the most likely buyers being the DOE customers with the old Requirements contracts containing 3.5-year termination provisions.

The short-term effect of the conversion to the FR contract on the secondary SWU market will depend on the terms and conditions of conversion, which DOE is expected to announce in the spring of 1983. [*Ed. note: the FR contract draft was never offered in final form but is expected to be revised in the as yet unannounced Utility Services enrichment contract (USEC)*]. There may be a

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short-term burst of activity, similar to that which occurred with conversion to the AFC contract. The immediate effect on the demand side would be to increase the number of potential intermediate-term buyers, due to the sudden shortening of the commitment period. Whether there will be many secondary market sellers to meet that demand will depend on the terms and conditions of schedule adjustment offered with conversion.

The draft FR contract was effectively repudiated by the market. Two major criticisms of the contract as proposed included:

1. the high termination charges that do not decrease with time;
2. the long lead time of 30 months required for assignments or substitutions of other DOE enriched material.

In addition, some DOE customers were dissatisfied with the FR contract concept completely and have requested that DOE simply return to offering the requirements contract form.

DOE's actions with regard to the conversion of existing contracts to proposed contracts are being watched very closely due to the dramatic effect a large scale conversion of AFC contracts to an FR-type form would have on the secondary SWU market.

EXHIBIT SIX

SWU POLICY ISSUES

Nuexco's review of trends in the enrichment services market has raised a number of issues concerning future SWU prices. This article will not attempt to resolve those issues. Rather, it will summarize some of the most important questions for the consideration of our readers.

Price Projections

Various government agencies have reported apparently conflicting projections for DOE SWU prices.

1. In June of this year, DOE issued a forecast of enrichment prices (in FY83 dollars) which showed a steady decline from the current $138 per SWU to about $112 in 1995. [United States Enrichment News, DOE, June 1982]

2. More recently, DOE issued an even more favorable forecast, with prices as low as $70 per SWU (in FY85 dollars) in 1995 declining to "about $50 SWU or less by the year 2000" if the Atomic Vapor Laser Isotope Separation (AVLIS) system meets expectations. ["New Enrichment Technology—What Can the Customer Expect?"; Fourth Annual Pacific Basin Nuclear Conference; Vancouver]

3. The Congressional Budget Office (CBO) has published an independent analysis, which agrees with DOE that the employment of either the advanced gas centrifuge or the atomic vapor laser technologies will result in lower enrichment costs in the long run (42 years). However, the CBO estimates average DOE costs for 1983-95 at *$230-$240 per SWU (in FY83 dollars).* [Nuclear Fuel; May 9, 1983]

4. The General Accounting Office (GAO), in a separate analysis of future DOE costs, has questioned the cost effectiveness of the Gaseous Centrifuge Enrichment Project (GCEP). Using DOE methods, but lower estimates of enrichment demand and power cost escalation, the GAO reports ". . . there are apparently no definite long-range cost reduction benefits associated with constructing GCEP. However, even if one accepts the position that building GCEP is economical, building the plant would not begin to reduce the average customer price for SWUs until after 1992." ["Issues Concerning DOE's Justification for Building the GCEP", GAO/EMD-82-88, May 25, 1982, and Supplement GAO/EMD-82-88S, June 24, 1983]

Question: As the Atomic Energy Act requires the full recovery of costs through revenues, what effect will the conflicting cost forecasts have on future DOE SWU prices?

Financial Analysis

As a result of the apparent conflict between the various government agencies on future DOE costs, it would seem worthwhile to investigate further the DOE cost structure. DOE prices are currently established on a complex system of cost accounts over a rolling 10-year period, and a complete analysis requires considerable effort. However, a cursory analysis of the 1984 DOE budget [United States Enrichment News, DOE, June 1983] indicates that further study is merited.

Total cash outlays in 1984, per the DOE budget, are $2.24 billion, or about $190 per SWU for the 12 million SWUs to be produced in 1984. After adding imputed interest and depreciation charges of $43 per SWU, the total cost of a SWU produced in 1984 appears to be $233, within the $230-240 range of the CBO's estimated average SWU costs for 1983-1995.

Conclusion

The actual price of future DOE enrichment services will be the result of complex calculations involving expected future costs and enrichment demand. In addition,

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past price projections may have given very conservative treatment to technological improvements. Thus, there may be legitimate reasons for the apparent discrepancies in future price projections. However, as DOE is required by law to obtain full cost recovery, its customers should develop a better understanding of the DOE cost structure prior to making significant decisions on future enrichment services.

The anticipated Utility Services enrichment contract will most likely require DOE customers to accept only DOE SWUs for the long term and forego opportunities to seek competing supplies from foreign enrichers. Whether it is in a utility's best interests (and those of its stockholders and ratepayers) to forego the long-term benefits of competition in return for near-term price concessions is an issue of fundamental concern to utility managers, their supervisors, and regulatory authorities. Answers to this question and others raised in this article will be important to those utilities facing SWU market decisions in the next few months. Not all parties are likely to arrive at the same conclusions.

The DOE action will definitely hurt the sellers of non-DOE SWUs with most potential buyers that are now in the market. Potential buyers having 3.5-year Requirements contracts will find the DOE offer more attractive than offers of non-DOE SWUs at the current secondary market price of about $90 per SWU.

To purchase SWUs of non-DOE origin on the secondary SWU market at $90, a buyer terminating a DOE 3.5-year Requirements contract for FY84 would have paid a net price of approximately $271.50 ($90 to seller plus approximately $37.50 per SWU to DOE for the usual 25 percent termination charge). By accepting the revised ISC and buying 40 percent of its desired quantity from a seller of DOE-origin SWUs (at a price of $102), one market participant has been enabled to reduce its average cost to $124 per SWU, a savings of approximately $3.50 per SWU over the secondary market price, as indicated in Table 8.

In the example shown in Table 8, a secondary market price for non-DOE SWUs of $86.53 per SWU would have yielded the same average unit cost ($123.99) that the buyer actually paid by accepting the revised ISC and buying 40 percent of FY84 requirements on the secondary market. Table 9 shows, for several different second-

EXHIBIT SEVEN

THE MODIFIED INTERIM SALES CONTRACT: EFFECT ON THE SECONDARY SWU MARKET

The secondary SWU market is reacting rapidly to the latest in the series of DOE efforts to stifle competition from sellers of Eurodif-origin SWUs. DOE has fundamentally altered the conditions of the secondary SWU market by modifying the terms of the Interim Sales Contract (ISC). Although Nuexco has not yet seen the contract itself (DOE officials say there are still a few details to work out), DOE has confirmed the contract's basic terms and conditions and that it is being offered to holders of 3.5-year Requirements contracts.

The new contract form is virtually identical to the original ISC (the so-called mini-deal), except that it allows the customer free substitution for purchases of some DOE—but only DOE—SWUs on the secondary market. Specifically, it allows the customer to purchase up to 40 percent of FY84 requirements and up to 60 percent FY85 requirements from secondary market sellers of DOE-origin SWUs without being assessed the customary termination charge. For FY84 SWUs, the savings to the customer amounts to almost $37.50 per SWU, based on 25 percent of the Requirements contract price ($149.85).

Table 8

POTENTIAL SAVINGS ASSOCIATED WITH MODIFIED ISC

	Quantity[1] (thousands of SWUs)	Price (US$/ SWU)	Cost (US$)
Option 1: Buy Non-DOE SWUS on on Secondary Market	200	90	18,000,000
DOE Contract Termination Charge		37.46	7,492,500
TOTAL			25,492,500
Option 2: Accept Modified ISC:			
Secondary Market DOE SWUs	80	102	8,160,000
ISC (same price as fixed commitment)	120	138.65	16,638,000
TOTAL			24,798,000

Option 1 - Option 2 = $694,500 = *$3.47* per SWU

[1]For illustrative purposes, the table assumes a nominal quantity of 200,000 SWUs. Unit prices are independent of quantity.

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ary market prices for DOE SWUs, the secondary market prices that would make secondary market buyers indifferent between the cost of non-DOE SWUs and the cost of DOE SWUs.

Table 9

SECONDARY MARKET INDIFFERENCE PRICES

Secondary Market Price for DOE SWUs (US$/SWU)	Buyer's Average Cost per SWU (US$/SWU)	Equivalent Secondary Market Price for Non-DOE SWUs (US$/SWU)
100	123.19	85.73
102 (Table 8)	123.99	86.53
105	125.19	87.73
110	127.19	89.73
115	129.19	91.73
120	131.19	93.73

Thus, for a given secondary market price (SMP) for FY84 DOE SWUs the equivalent secondary market price (EP) for non-DOE SWUs is derived as follows:

1. EP = 60%(ISC price) + 40%(SMP) – Termination charge;
2. EP = 60%($138.65) + 40%(SMP) — 25%($149.85);
3. EP = $83.19 + 40%(SMP) — $37.46;
4. EP = $45.73 + 40%(SMP).

The necessary offering price would then be determined by subtracting the amount necessary to motivate buyers to accept non-DOE SWUs in preference to DOE-origin SWUs.

Prior to the announcement of the original ISC, holders of 3.5-year Requirements contracts needed to receive a price of $112.39 in the secondary market to offset their termination charges. Sellers of DOE SWUs needed to offer at approximately $108, while sellers of non-DOE SWUs needed to offer at approximately $100, to provide the incentive necessary to motivate buyers to action. Upon the announcement of the original ISC, the indifference price for 3.5-year Requirements contract holders dropped by $11.20, to the level of $101.19. Consequently, sellers of DOE SWUs reduced their offering prices to the range of $95-100 and sellers of non-DOE SWUs reduced their offering prices to approximately $90. Historically, secondary market sellers of non-DOE SWUs have had to offer discounts of approximately $10-12 per SWU in order to compete successfully.

Owners of excess DOE-origin SWUs are beginning to recognize the changes brought about by this new situation. Some have already raised their prices to the $115 level. We anticipate that more will do so. Secondary market prices for DOE SWUs presently fall primarily in the range of $110-115. Two factors have been significant in the establishment of that price range.

1. The large short-term supply of DOE-origin SWUs on the secondary market;
2. The recognition by DOE sellers that even at prices approaching $115, buyers that accept the modified ISC still can achieve considerable savings. Prices could move even higher but for the anticipated competition among sellers. At the $110-115 price level for secondary market SWUs of DOE origin, the buyer's indifference price for non-DOE SWUs is $89.73 to 91.73.

Holders of 5-year Requirements contracts are not being offered the modified ISC (just as they were not offered the original ISC), so their indifference price is a simple function of the Requirements contract price and termination charges. Allowing for a 40 percent termination charge yields an indifference price of 60% x $149.85 = $89.91, a figure that falls within the range of secondary market prices for non-DOE SWUs equivalent to secondary market prices for DOE SWUs in the range of $110-115. Thus, the secondary SWU market is approaching the point at which holders of 5-year Requirements contracts can be drawn into the market in large numbers.

Most 3.5-year Requirements contract holders that decide to accept the modified ISC naturally will want to contract for DOE SWUs on the secondary market to reduce their average costs below the DOE Fixed-Commitment contract price of $138.65. Having thus restricted potential secondary market purchases to SWUs of DOE origin, the potential buyer would become vulnerable to increases in the secondary market price for DOE SWUs. If the secondary market supply of DOE SWUs proved insufficient to meet demand, then the secondary market price for DOE SWUs could approach (or slightly exceed) the $130 level. Any greater price would remove the incentive to act, so that a price of approximately $130 should be regarded as a short-term ceiling on the price of DOE SWUs on the secondary market.

Therefore, utilities that plan to accept the revised ISC will wish to arrange their secondary market purchases for both FY84 and FY85 as soon as possible, perhaps even before accepting DOE's offer. In our opinion, secondary market sellers of non-DOE SWUs will also pursue actively the potential market for FY85. The secondary market

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price and availability of FY85 SWUs of non-DOE origin will be a factor in some potential buyers' decisions to accept or decline DOE's offer of the revised ISC.

In that case, if DOE prices for FY85 were unchanged from FY83-84, and assuming a $115 price for secondary market sales of FY85 SWUs of DOE origin, the equivalent secondary market price for non-DOE SWUs would become 40%($138.65) + 60%($115) - $29.97 = $94.4, the indifference price for FY85SWUs of non-DOE origin.

The modified ISC will certainly result in the sale of more DOE SWUs to 3.5-year Requirements contract holders for FY84 and FY85. But at what cost? For purposes of analysis, assume that DOE's offer of the modified ISC will prevent the termination of 2 million FY SWUs. That means DOE will be giving up approximately $75 million in termination charges that would have been assessed on those 2 million SWUs. Assuming maximum utilization of the free substitution provisions of the modified ISC, 800 thousand SWUs will be furnished by sales from inventories of DOE customers, while DOE production will increase by 1.2 million SWUs, to be sold at $138.65 per SWU. Thus, sales revenues will increase by approximately $166 million. The *net increase* will be approximately $91 million, or $76 per SWU. In essence, DOE is underselling the competition from the secondary market.

In summary:

1. DOE has indicated that it intends to be very aggressive in trying to retain its 3.5-year Requirements contract holders.

2. DOE has altered the conditions of the secondary SWU market again by modifying the terms of the Interim Sales Contract for FY84 and 85.

3. The effects of DOE's latest actions are:

a. To lower the cost of DOE SWUs to $138.65 to holders of 3.5-year Requirements contracts.

b. To provide these 3.5-year Requirements contract holders the opportunity to lower cost further by allowing them to purchase DOE SWUs in the secondary market.

c. To provide an outlet for excess SWUs held by DOE customers (primarily AFC contracts) and to raise the secondary market price of those DOE-origin SWUs.

d. To increase DOE production in exchange for marginal revenues of approximately $76 per SWU, a figure well below variable cost of production.

EXHIBIT 8

SOURCES OF SECONDARY SWU MARKET SUPPLY AND DEMAND

The bulk of **secondary market SWU supply** comes from inventory surpluses and excess commitments associated with DOE Fixed-commitment contracts (both US and non-US customers) and with Eurodif shareholders' obligations to accept deliveries of enrichment services in excess of need. The amount of DOE excesses moving into the market from non-US customers is normally smaller than that available from US customers, but the foreign customers appear more willing to sell at lower prices.

In order to more fully understand the composition of the secondary SWU market supply and demand, some review of DOE contract terms and conditions is necessary. (Exhibit 1 discusses them in more detail.)

The Requirements contract, offered from the inception of the commercial enrichment business until 1972, has two types, differentiated from one another only by their termination provisions. As the customer gives DOE shorter notice periods under Requirements contracts having 3.5-year termination provisions, termination charges increase. Termination charges are zero for notices of 3.5 years or more, while notices of less than one year incur the maximum penalty, 25 percent of the SWU price in effect when the termination notice is received by DOE. Under Requirements contracts having 5-year termination provisions, the customer can partially terminate deliveries at no charge 5 years into the future. For terminations giving less than 5 years' notice, DOE levies a charge of 40 percent of the SWU price in effect at the time notice is received.

The Long-term Fixed-commitment (LTFC) contract, offered in 1973 and 1974, has a ten-year rolling firm commitment period. Unlike the Requirements contracts, wherein the customer need only accept SWUs sufficient to fill actual requirements as defined 180 days in advance of delivery, LTFC contracts caused inventories and commitments to increase to alarming levels. Industry furor over the burden of those inventories led DOE to offer a second generation fixed commitment contract in 1978. This contract, known as the Adjustable, Fixed-commitment (AFC) contract, permitted holders of LTFC contracts to convert to the AFC contract and make a one-time free adjustment to their commitment schedules so as to restore balance between requirements and scheduled deliveries.

The AFC contract contains a five year rolling period of firm commitments (allowing quantity flexibility in the fourth and fifth years). This shorter firm period was clearly an improvement over the LTFC contract, so most

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of DOE's LTFC customers converted to the new contract. Only 15 LTFC contracts remain in effect, 5 in the USA and 10 elsewhere. By contrast, US customers of DOE hold 104 AFC contracts and non-US customers hold 81. Relief obtained under the terms of conversion to the AFC was short-lived, and excess commitments and inventories once again built up rapidly under the Fixed-commitment contracts.

The foreign enrichers (currently Urenco, Eurodif and Techsnabexport) entered the primary market for enrichment services in the mid-1970s, ending the monopoly that the AEC (now DOE) had enjoyed. Two aspects of foreign SWU supplies should be mentioned here. First, under political pressure, several German utilities terminated the remaining deliveries under their Requirements contracts in order to take supplies from Urenco (with its German participation). These terminations represent a long-term loss of business to DOE of approximately 300,000-400,000 SWUs per year. Second, the Eurodif shareholders are responsible for taking their respective shares of the Eurodif output. In many instances, these SWUs are not needed to support their nuclear power programs. As a result, large inventories of Eurodif-produced SWUs have developed in Europe and the outlook is for those excesses to increase. The fact that so many of those non-DOE SWUs simply are not needed in the foreseeable future is the most important reason for their owners' aggressive sales efforts on the secondary market. The recent strength of the dollar relative to certain European currencies has made sales to US buyers even more attractive. However, secondary market sales of non-DOE SWUs constitute a relatively small portion of the secondary market SWU transactions, especially when compared to the historical level of assignments of DOE SWUs.

When DOE allowed LTFC contract holders to convert to the AFC contract, DOE's business began to erode due to assignments and a contract loophole that became known as "zero free termination". One of the flexibilities in the AFC contract allowed customers to reduce their AFC commitment to DOE to the extent that they substituted for those commitments material previously enriched by DOE. As no fee was associated with this flexibility, a very active assignment market arose in the late 1970s and early 1980s.

Through the assignment mechanism, DOE's customers have assigned away commitments for more than 11 million DOE SWUs for delivery in the period 1983-1990. Non-US customers of DOE have assigned away commitments for over two million SWUs for delivery in the same period. The zero free termination loophole has had a similar effect on DOE SWU supply. By taking advantage of the termination mechanism in the contracts converting from LTFC to AFC, DOE's US customers terminated 8.2 million SWUs and the non-US customers shed another 3.5 million SWUs. In total, DOE has lost more than 25 million SWUs to assignments and zero free termination since the release of the AFC contract. By contrast, 1982 and 1983 secondary market sales have accounted for approximately 5 million SWUs, of which 40-50 percent were of foreign origin. Thus, Assistant Secretary Brewer's contention that the secondary market has "arisen in the past 10-12 months" will not stand the test of scrutiny. It is true, however, that only in the past two years have sales (deenrichment swaps or sales of enriched UF_6), as opposed to assignments, become the predominant portion of the secondary SWU market.

Up until two years ago, most **secondary market SWU demand** came from AFC contract holders and was satisfied by assignment of excess future commitments. Separative work commitments cannot be assigned into Requirements contracts. For the situation in which a DOE customer wishes to assign SWUs from an AFC contract to a DOE Requirements contract holder, DOE developed a contract called the "AFC for Assigned Enrichment Services." A few of these contracts have been issued, but few SWUs have been involved in comparison to the amount of SWUs assigned into AFC contracts.

1. US utilities have accepted assignments of 7.7 million SWUs into their fixed-commitment contracts for delivery in the period 1983 through 1990.
2. For the same delivery period, non-US customers of DOE have accepted assignments of 5.6 million SWUs into their AFC contracts.

During the early 1980s, holders of DOE Requirements contracts became important buyers of secondary market SWUs—both DOE origin and non-DOE origin. A small number of 5-year Requirements contract holders have terminated future deliveries to take secondary market SWUs, but by and large, the 3.5-year Requirements contract holders account for the large majority of secondary market SWU demand in the present market.

EXHIBIT 9

LIKELY RESULTS OF THE USEC

It is difficult to predict how many DOE customers will convert to the new Utility Services enrichment contract (USEC). The success of DOE's efforts to induce customers to accept the Utility Services contract (USEC) will

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depend largely on the contract's terms and the conditions for conversion to it, neither of which is yet final. DOE is reportedly still "market testing" the contract in order to address the negative responses it has received from utility executives allowed to review a preliminary version. In addition, DOE has just released a modified Interim Sales Contract that is being viewed positively by several 3.5-year Requirements contract holders, even though it establishes a tenuous commitment on the part of the customer to accept the USEC if, when released, it is "at least as good as" the contracts they have now. However, Nuexco's assessment of the most likely terms indicates that DOE's success will likely be quite different for different classes of customers.

1. **AFC contracts**—Virtually all US customers holding AFC contracts, perhaps 90-100 percent, will be predisposed to convert to the USEC. Already committed to ten-year contracts having very high termination charges, the AFC holders will value highly the USEC's improved supply flexibility. They will be getting a valuable benefit at a relatively small cost. The requirement to accept DOE as a sole-source supplier will be the only significant drawback. Most non-US AFC customers are also likely to convert, but due to political factors the percentage of customers predisposed to converting is not likely to be as high—perhaps 60-80 percent. For many in this group of customers, the commitment to take all of a reactor's requirements from DOE for the unit's entire lifetime would be so onerous as to eliminate the possibility of their accepting the USEC, regardless of the inducements offered. As a final note, it now appears that those customers having AFC contracts associated with cancelled or deferred nuclear units will not be allowed to convert to the USEC. If so, relief would be denied to the group of customers most in need of it.

2. **3.5-year Requirements contracts**—Holders of 3.5-year Requirements contracts are the least likely to convert. Perhaps 15-25 percent of these contracts will be converted, and those will be utilities that, for political rather than economic reasons, probably would not purchase foreign SWUs anyway. We do not see how any foreseeable form of the USEC can equal the value of the current 3.5-year Requirements contract in meeting the utility goals of supply assurance, flexibility, and reasonable cost.

a. With the right to adjust supply to requirements with only 180 days notice, this group currently has very flexible supply terms.

b. They are currently paying about 8 percent higher prices than they would under the AFC or the new USEC contracts, but they are provided protection from significantly higher prices by an escalated price ceiling clause that will almost certainly be absent from the USEC.

c. Having the right to cancel their DOE supply and buy on the secondary market by paying reasonable termination charges, they have the flexibility to exploit secondary market opportunities. Thus, they already have access to the lowest potential cost enrichment services of any current or anticipated future contract. DOE may offer a short-term advantage for the USEC, but the great majority of utilities probably will decide in favor of the continuing benefits of the 3.5-year Requirements contract.

3. **5-year Requirements contracts**—The holders of 5-year Requirements contracts also will be reluctant to convert. While most of these customers have told Nuexco they will *not* convert to the USEC, the number that will actually do so is still quite uncertain. The 5-year Requirements contract holders least likely to convert are several utilities that have been terminating annual deliveries on a rolling basis five years into the future.

The 5-year Requirements contract holders already have the flexibility to adjust their supply to equal the reactor's requirements on only 180 days' notice, and they would be giving up the right to terminate future deliveries at no cost beyond 5 years if they signed the USEC. The success of DOE's conversion efforts in this category will depend on the near-term incentives offered.

If substantial numbers of Requirements contract holders accept the USEC, it will have two immediate effects on future DOE deliveries.

1. The free substitution in the near term of material previously enriched by DOE will cause a flurry of secondary market activity, thereby reducing DOE deliveries during the transition period.

2. The free substitution provisions also will lead to the creation of a two-tiered secondary market, in which the price of DOE SWUs will be about $20-30 higher than that of non-DOE SWUs. The higher prices will also stimulate more secondary market selling from AFC contract holders' excess inventories. There will continue to be a secondary market for non-DOE SWUs, in which the buyers will be Requirements contracts holders that have not converted.

In the long term, conversion of a substantial number of Requirements contracts would have at least two significant effects on DOE deliveries. (In this context, the long term is the period after which DOE-origin excess inventories have been fed into the new USEC contracts under the free substitution provisions.)

1. Given our current understanding of the contents of the USEC, a utility could not terminate for a fee which

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would make it advantageous to purchase non-DOE origin SWU. Thus DOE demand in the long term would be increased to the extent that DOE succeeds in eliminating its secondary market competition.

2. If the Requirements contract holder wishing to convert has fewer years of deliveries remaining under his Requirements contract than would be covered by the USEC, then DOE would have increased its firm long-term commitments by eliminating the option to switch primary suppliers upon expiration of the Requirements contracts.

MR. WOLCOTT'S RESPONSES TO QUESTIONS DURING THE HEARING

Mr. OTTINGER. Mr. Robert Wolcott, the Chairman of Nuexco, Menlo Park, California.

Mr. Wolcott, we thank you for being with us. We have had an opportunity to read your full statement, and I would appreciate if you might summarize briefly and then answer questions.

Mr. WOLCOTT. I thank you for the invitation. I would like to introduce my associate here, Mr. R. Wesley Miller, our Vice President and Chief Market Analyst.

I think I can keep my comments fairly brief. Mr. Brewer has described the changing environment in the market. I would point out that my particular vantage point relative to this problem is somewhat different, being shaped more by commercial than government experience. Nuexco operates out in the market, and I am certainly not an expert on the inner functioning of DOE. The secondary market developed really out of a need to do something about the excesses which I think everybody recognized.

I would also point out that although the Italians have been quite important in that secondary market recently, they are by no means the only participants in that market, and not all of the SWU which are being exchanged in the secondary market are Eurodif-origin SWU. Some SWU is being sold out of the United States, going from DOE customers into the European market. Some DOE SWU is being sold out of Europe back into the US market, and there have been a number of contract assignments, and so on, in the Far East.

I think that the secondary market has probably come on fairly strong in the last year or so, but probably it is going to be a permanent feature of the market, simply because you never quite get a perfect balance between SWU supply and demand, and somehow this problem has to be taken care of. The secondary market is the mechanism by which that happens.

Our figures indicate that thus far the secondary market has not taken a big share of the DOE market for this fiscal year. It is a little over 10 percent. I think the figures are actually about 12 percent. We anticipate it probably will go on like that for several years. We don't know of any long-term contracts that have been placed by non-US sources (non-DOE) in the United States, but there is the possibility that one or a few could be placed in that way.

DOE has a number of problems. I think these problems make it difficult for DOE to respond to the market very easily or very effectively, because of the constraints placed on them. However, even if DOE could respond I would certainly question from a business standpoint the desirability of doing so. If you are the largest supplier in the world, and you attempt to follow a very volatile secondary market, you almost certainly run the risk of trapping yourself into a position where you will not be able to recover and maintain your position in the primary market.

I am somewhat less optimistic, I think, about DOE's ability to maintain a long-term position in the overseas market. I have been associated with the power business for many years, and the usual pattern is that the US supplies in the early days, for example nuclear power plants, and turbine generators, but eventually nationalism prevails. Local countries take over the supply. Now this has happened, of course, in Europe with Eurodif and Urenco. It has happened in other areas, such as Japan, which produces its own nuclear power plants and its own fabricated fuel. They are working on processes to do their own enrichment, so this market is going to be very difficult to hold, and I am not sure that price alone will be the variable which allows us to stay in that market.

Mr. OTTINGER. Elaborate on that a little bit.

Mr. WOLCOTT. Let me use the Japan Nuclear Fuel Company as an example. I had a part in setting it up, I know its history quite well. I was with General Electric at the time. G.E. started out furnishing all of the fabricated fuel from the United States for Japan. Then Japan and G.E., in combination with two Japanese partners, established a nuclear fuel fabrication plant in Japan. At first the Japanese plant furnished maybe 10 or 15 percent of

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the Japanese need for the reactors, while G.E. furnished the balance. Then the portion of Japanese manufacture grew, and today all of the fabricated fuel is made in Japan.

This same pattern has applied in other things too. It applied to the nuclear power plant itself. It applied previously to turbine generator systems, and the whole line of heavy equipment. If you look at the overseas power market, nearly all of those markets are supplied from national entities.

For example, I think it has been a long time since a US company has sold a turbine generator into England, Germany or France. This transition doesn't happen all at once. It happens over a period of time, and it may not happen for many, many years in Japan, but you always have that threat. You always have that trend to deal with.

Mr. OTTINGER. Regardless of the economics?

Mr. WOLCOTT. Regardless of the economics.

Mr. OTTINGER. Go ahead. Proceed.

Mr. WOLCOTT. I would say that I think that any action which is taken in order to frustrate the function of the secondary market is not really worthwhile. It is very important to get these problems out of the system. This has happened to uranium. Uranium has had a very difficult time and is still having a difficult time. At least uranium is getting into the latter phase now where the secondary market is solving some of the problems. And although the enrichment problem lags behind the uranium problem, I don't see any alternative but to working its way through this convulsion that goes along with getting rid of the excesses. If you try to inhibit that adjustment I think you should prepare for a bigger convulsion later on.

Based on my own business beliefs, too, I do not think it is good for the United States to worry too much about trying to be the lowest priced supplier in the world. I think the US, being the largest volume supplier, really ought to be the price leader, and the others will follow it up.

But as a matter of business generally, if you are the largest volume supplier and you try to reduce prices to match the fellow who is trying to build or maintain his market position, you generally erode the whole primary market. I think that should be a major concern for the United States.

I can take whatever questions you like from here.

Mr. OTTINGER. Do you think on a straight business basis it would be wise for the United States to get out of its uneconomic production and buy its needs on the world market?

Mr. WOLCOTT. This is what happened in the uranium business. The price of uranium got low enough so it was more economical for producers to buy on the local markets and supply their contracts because they could buy more cheaply than they could produce. This does have an advantage in that it is one way to soak up excesses for the market fairly rapidly and get back to a more stable condition.

This was very helpful in the uranium market. At one time, two-thirds of the buyers for uranium were producers rather than users. Certainly that is an alternative worth looking at, because the secondary market price is probably down below or close to just the electrical power costs today for the diffusion plants.

Mr. OTTINGER. Ms. Hull?

Ms. HULL. Mr. Wolcott, have you had the opportunity to review the sales contract and proposed modified version?

Mr. WOLCOTT. I have not personally.

Mr. MILLER. We have seen the Interim Sales contract that was issued in July, but we have not yet seen the modified version issued week before last.

Ms. HULL. At this point is your information sufficient so you can speculate as to the effect these offers might have on the customers?

Mr. WOLCOTT. Yes, we have a lot of information relative to them. I just haven't read the particular draft.

Ms. HULL. Would you like to give us your impression of the effect these offers will have on DOE's customers and on the market in general?

Mr. WOLCOTT. Well, the first one, the Interim Sales contract, that dropped the price for the 3.5-year Requirements contract about $11. That, in turn, stimulated the secondary market to drop its price about $11 in order to maintain the same level of incentives. A few utilities did accept that Interim Sales contract. There are quite a number that have not. Then there was a second version, what we call the modified Interim Sales contract and this in essence allowed for much freer exchange of DOE SWUs among customers. That could have a number of effects.

I think we will have to wait and see exactly what shakes out of that. Certainly one effect was to increase the price for DOE secondary SWUs, because money which previously flowed to DOE under termination charges now in essence flows to the seller of DOE SWUs. So I think it raised the level of activity and the price.

It may also have an effect on the foreign markets. For example, Enusa handles all the fuel business for Spain. They have a Russian contract. I think they also have Eurodif and Urenco contracts. They also have DOE contracts. Of course they have excess SWU now.

Obviously they will sell the SWU that is most valuable on the secondary market. That would be DOE SWU, so it

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may tend to funnel DOE SWU back into the US market. Enusa could then use the SWU which is produced elsewhere, because all SWUs are the same as far as use is concerned. However, they are not all the same as far as market value is concerned.

Ms. HULL. Do you have any conclusions or comments on the actions that have resulted from DOE's proposed contracts?

Mr. WOLCOTT. I have some thoughts related to modification to DOE's Interim Sales contract. Mr. Miller made some calculations that would indicate to us that its net effect is for DOE to sell more SWU at a net revenue gain of around $76 per SWU. Perhaps you could expand on that.

Mr. MILLER. Exhibit 7 of Mr. Wolcott's remarks goes into detail. For purposes of analysis, we could assume that by offering the modified Interim Sales contract, DOE might have forestalled the termination of some quantity of Requirements contracts SWUs, say two million. In the end the quantity doesn't matter to the conclusion. If we assume that those customers that accept the DOE offer of the modified Interim Sales contract take maximum advantage of its free substitution provisions, and thereby acquire 40 percent of their two million on the secondary market from sellers of DOE SWUs, then DOE gains the sale of 1.2 million SWUs. At $138.65 per SWU, that would produce revenues on the order of $166 million.

However, in order to induce the additional sales, DOE would have foregone the termination charges on the total quantity of forestalled SWUs. In this example, the quantity of two million SWUs equates to roughly $75 million. So the net increase in cash flow would be on the order of $91 million, or $76 per SWU in marginal revenue per each additional SWU sold by DOE.

So for every SWU by which DOE increases its sales as a result of customers accepting the modified Interim Sales contract, marginal revenues amount to around $76. And that we believe is well below the variable cost.

Ms. HULL. For a moment can we just pretend a role play? Would you imagine for a moment that you are a fuel manager for a domestic US utility. What would you do now on behalf of your company if your company held a 3.5-year Requirements contract with DOE?

Mr. WOLCOTT. I would keep it. It would take quite an inducement for anyone to give up a 3.5-year Requirements contract because you have a great deal of flexibility. And if associated with that inducement in any way was a provision which would lock you into sole source supply for 20 or 30 or 40 years, whatever it may be, I think you would be extremely reluctant to accept that. And that is the attitude of the utilities, too.

Ms. HULL. Would that apply as well to holders of 5-year Requirements contracts?

Mr. WOLCOTT. The indications we have are that you probably have some 5-year contract holders who might change, and some who will not. The utilities themselves, you know, are not a monolithic group. Some insist on domestic supply and I think you can count on a certain amount of DOE SWU, no matter what.

Those insisting on DOE SWU are the easiest to change because they don't anticipate doing anything else anyway. So they take the concessions. Then there are others that are willing to buy either overseas or domestically, and they put a much higher premium on the flexibility.

I don't know how this proportion might break down, but we do know there are some on both sides.

Ms. HULL. Do you have any feel for the proportions that might go one way or another?

Mr. MILLER. We have done some studies on the subject, but not in a rigorous quantitative fashion. We have sampled opinions among our brokers who we believe are very close to utilities, and we have a clear consensus that very few 3-5 year Requirements contract holders would convert to what we expect to see in the Utility Services contract (USEC). They would perceive little incentive.

On the other hand, the most likely response of 5-year contract holders is not so clear. The degree to which the USEC grants them access to easy substitution of DOE SWUs in the short term would be an important factor in their decision to convert or not convert to the USEC. AFC contract holders would be more likely to convert to the USEC than would Requirements contract holders, but even they would be deterred—and Nuexco believes substantially so—by the provisions binding them to sole-source supply (DOE) for the remainder of their reactors' lifetimes.

Ms. HULL. So is it fair to say that your conclusion is that DOE's goal of having most of its customers on one type of contract is somewhat illusory?

Mr. WOLCOTT. Yes. I really don't think there is any possibility at all of that happening because, to set all customers under one type contract, DOE would have to offer something good enough to attract the most reluctant 3.5-year Requirements contract holders. This would be very costly because you have to take in all the others. You would be really pricing to the most difficult customer and giving everybody else the advantages.

I think what you end up with is one more combination of contracts.

Ms. HULL. Thank you.

Mr. OTTINGER. We thank you very much for your help, Mr. Wolcott. Appreciate your being with us.

Mr. WOLCOTT. Thank you.

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PART TWO: OTHER TESTIMONIES

OPENING STATEMENT OF THE HONORABLE RICHARD L. OTTINGER

Chairman of the House Subcommittee on
Energy Conservation and Power

Today the Subcommittee will receive testimony on the state of the uranium enrichment program of the Department of Energy, its goals, and its strategy to achieve those goals.

Although the enrichment program alone represents over 20 percent of DOE's budget, it has been able to keep a relatively low profile by its ability to offset federal appropriations with revenues received for its services. This equilibrium may be upset in the FY 1985 budget due to decreasing revenues concurrent with a burgeoning construction program.

DOE has suffered losses of direct sales customers to foreign enrichment services suppliers and to the glutted secondary market. In an attempt to prevent further losses, DOE has offered price and other inducements to its customers. These inducements, if accepted, will further reduce DOE's revenues, although perhaps lessen the loss of sales. We look forward to DOE's analysis of the impact these losses have had and will have on its budget.

I have made no secret of my belief that DOE's current construction program is too much too soon. This Committee is interested in working with the Department to stabilize a rational, coherent and efficient program for providing needed uranium enrichment services. It is crucial that the Department establish its program direction, marketing goals, and an achievable strategy which can generate wide consensus prior to the submission of the FY 1985 budget.

The Department has been working throughout the summer to completely reassess the enrichment program. I am disappointed that the Department has not been able to complete its reappraisal in time for this hearing, as was originally intended. I hope that the Assistant Secretary will provide the Subcommittee with some insight on the progress of this appraisal.

I have requested that today's witnesses review the enrichment market situation and provide the Subcommittee with their assessments of current and future demand for United States enrichment services and the effect of DOE's recent actions on short- and long-term enrichment demand. The Subcommittee is interested in the extent of the threat to DOE's revenues posed by the active secondary market and the possible effect the draft Utility Services contract will have on DOE's market.

A marketing goal is necessary to determine the need for, size, and timing of DOE's planned construction program.

The recent reports of the General Accounting Office and the Congressional Budget Office graphically demonstrate the promise and potential of the advanced enrichment technologies. I am committed to assuring that these technologies are pursued as aggressively as possible. The estimated dates of commercial deployment have advanced rapidly. In view of this, I would not be favorably inclined to an enrichment budget request which did not include sufficient funds to enable prompt commercialization of the most cost-effective technologies.

TESTIMONY OF SHELBY T. BREWER

Assistant Secretary for Nuclear Energy
Department of Energy

Introduction

The world market for enriched uranium and the US share of that market have changed dramatically over the past 10 years. In the past 12 months the character of the US domestic market also has begun to show evidence of change. As matters now stand, the US is not competitive with other producers, nor are we competitive with excess world inventories. To reclaim our leadership in international nuclear commerce, we must find a sound, businesslike route through this market crisis, so that we will emerge at the other end with superior enrichment technology, production capability, and economics. The key to achieving this transition is a clear understanding of the market, based on realism rather than wishful thinking, and a commitment to make decisions based on sound business principles.

For the past nine months, as the erosion of our US domestic market became evident, the Department has been conducting an intensive review of its enrichment enterprise, with an eye toward adjusting its business posture (pricing, contracting, etc.), as well as its long-term strategic plan for production and technology deployment. I would like to describe in some detail the evolution of the uranium enrichment market and prospects for the future.

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Evolution of the US Uranium Enrichment Enterprise (1964-1973)

In the early 1960s, enriched uranium was government-owned and leased to utilities. In 1964, the Private Ownership Act authorized the ownership of nuclear fuel by licensed utilities, and from 1969 to 1972, DOE contracted with utilities under a Requirements contract, which was very flexible to the utilities and very inflexible to the government. In 1973 and 1974, the government established the Long-term Fixed Commitment contract, with a firm 10-year utility commitment requiring firm quantities and delivery dates.

Evolution of Competition

The United States monopolized the world enrichment market until the mid-1970s. When the United States closed its order books in 1974, we indirectly gave a large boost to the European suppliers who were already in the process of constructing capacity for their own national supplies. The Eurodif plant achieved initial operation in late 1976. Current Urenco capacity is 1 million SWUs per year, with plans to expand further as additional enrichment contracts are signed. Finally, Techsnabexport (USSR) sells excess enrichment services, primarily as a means of obtaining hard currency. They have about 3 million SWUs per year excess capacity available for sale, but are not expected to be a major force in the future.

Both Eurodif and Urenco have developed aggressive marketing programs to expand their contracting base and thus reduce the drain of idle excess capacity on their financial position. Eurodif's marketing is now performed by Cogema, which recently made two sales to domestic utility customers, and appears to be targeting major DOE markets for additional sales opportunities. Eurodif and Urenco are both able to offer more flexible contractual arrangements than is DOE, as each Eurodif contract can be individually negotiated. At present, Eurodif enjoys a price advantage over DOE, primarily because of the devaluation of the French franc.

Loss of Foreign Market

Until 1973, the US enjoyed 100 percent of the foreign enrichment market. The order books were closed in 1974 and remained closed until 1978. By then, Eurodif and Urenco had siphoned off about 30 percent of the non-US market. By 1980, our share had decreased to about 35 percent. Between 1980 and 1982 we have regained some ground—to about 38 percent of the foreign market. In the late 1970s, the US image as a reliable supplier was further undermined through the evolution of a more restrictive nuclear export policy. The Nonproliferation Act of 1978 projected the US as arrogant and condescending. Before 1981, the US held a significant price advantage over Eurodif and Urenco. Escalation of power costs, as well as the strength of the US dollar have now placed the US at a price disadvantage with foreign suppliers.

Erosion of the US Domestic Market and Emergence of the Secondary Market

In the past 10 months the domestic uranium enrichment market has been threatened for the first time, both by sales of foreign-origin material to US utilities on the secondary market and by loss of primary sales to foreign producers. As with the foreign market, this domestic erosion can be traced to unfavorable price and contract terms.

The central problem facing the US enrichment enterprise is a massive imbalance between world production and consumption. Utilities are willing to resell their excess enriched uranium at prices below current costs, through secondary market transactions. The US is beginning to absorb the excess. Several utilities have terminated DOE contracts, in the past year in favor of European producers. In general, they were lured in that direction by the uncertainty in US price growth, by the strength of the US dollar, by tailored contracts as opposed to the rigidity of US enrichment contracting practices, and by the lack of clarity in our long-term enrichment policy.

Uranium Enrichment Market Projections

Our recent analyses of the SWU demand to be supplied by DOE have been predicated on the basis of a 1983 projection of US nuclear power growth to 110-150 gigawatts of nuclear electric generating capacity in the year 2000. Our pessimistic estimate of DOE's share of the world market is less than 45 percent of the EIA mid-case projection of 350 gigawatts of free world LWR capacity in the year 2000.

Our projection of worldwide supply represents expected deliveries to free world utilities currently committed under contracts to one of the world's primary enrichment suppliers. During the next few years, deliveries will continue to exceed demand; these excess deliveries will be added to the already large inventories held by utilities. Whereas DOE has contributed to this buildup through its Fixed-commitment contracts, the majority of the inventory was produced by other suppliers. Currently, France, Italy, and Spain hold the largest portions of this inventory, and Italy and Spain have the greatest incentive to dispose of their inventories, as their nuclear

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programs have experienced massive delays. The owners of these inventories are actively seeking to sell material on the secondary market by offering prices below those of primary suppliers.

DOE's Requirements contracts holders are the primary candidates for the disposal of secondary market material, because of the lenient termination provisions in these contracts and the small number of Requirements contracts held by foreign suppliers. DOE has 75 Requirements contracts with domestic and foreign customers. Under 45 of the contracts, the customer can terminate without penalty with a 3.5-year notice. The remaining 30 contracts permit free termination with 5 years notice. Because of the large discounts available on the secondary market, requirements customers with 3.5-year termination provisions can terminate deliveries from DOE, pay the termination penalties, and still save money by purchasing SWUs on the secondary market. The terminations received in advance are growing yearly, reflecting the customers' desire to avoid termination charges and buy on the secondary market. While no expected terminations are shown for customers with 5 year provisions, some could develop as sellers on the secondary market begin to offer SWUs at prices low enough to offset the 40 percent termination charge. Reversal of these trends is essential for DOE to retain financial viability.

Conclusions

The US has not operated the enrichment enterprise as a business; over the years we have misread or disregarded the market; we have handcuffed ourselves with contracting and marketing constraints; we have acted as though we are monopolists when we are not; we have antagonized all of our customers, both foreign and domestic. We are not competing but reacting.

The potentially very serious loss of market, and the attendant revenue loss, come at a time when we are engaged in major investments in advanced technology to regain market leadership, and at a time when we are trying to minimize net positive appropriations. I would suggest that we break the problem into two parts: how we deal with urgent but transient near-term market problems, and how we emerge in a technologically and economically commanding position when this transient has passed and supply and demand forces once again determine new production.

The market, revenue, and financing problems that we face will be very difficult to solve. However, the comprehensive strategy currently being developed, which will be presented in concert with the FY 1985 budget, will contain measures to address the difficult short-term problems with a program that is financially and technically sound.

STATEMENT OF DR. ROBERT CIVIAK

Specialist in Energy Technology
Science Policy Research Division
Congressional Research Service

World Enrichment Supply

There are four primary enrichment suppliers. The United States Department of Energy, the Soviet Union, Eurodif and Urenco. Together they are currently capable of producing about 42 million SWUs per year, more than twice the needs of all the world's nuclear powerplants. If those suppliers complete enrichment plants now under construction as scheduled, and do not retire any existing plants, their capacity will increase to over 55 million SWUs per year by 1995. Enrichment plants under construction or planned in Japan, Australia, Brazil, and South Africa may add another 3 million SWU per year by 1995.

In addition to the primary suppliers, a secondary market in enrichment has developed, which could represent a major source of supply over the next few years. The origin of the secondary market is private stockpiles of enriched uranium which have accumulated because customers were bound by long-term contracts to purchase enrichment in excess of their needs. There are currently about 30 million excess SWUs held by enrichment customers, about one and a half times the amount of enrichment produced by the primary suppliers last year, so private stockpiles represent a substantial supply of enrichment.

Table 10 summarizes the existing enrichment plant capacity and the planned capacity of primary Western suppliers in 1990 and 1995. Actual production might be significantly lower. For example, while the US capacity has been 27 million SWU per year for the past two years, actual US production has been at or below 12 million SWUs per year.

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Table 10

WORLDWIDE URANIUM ENRICHMENT CAPACITY: EXISTING AND PLANNED (millions of SWUs per year)

Supplier	Process	Existing Capacity 1983	Planned Capacity 1990	Planned Capacity 1995
United States				
Oak Ridge, Tenn.	diffusion	7.9	7.9	7.9
Paducah, Kent.	diffusion	11.4	11.4	11.4
Portsmouth, Ohio	diffusion	8.0	8.0	8.0
Portsmouth, Ohio	centrifuge	—	2.2	13.2
Subtotal US	diff. + cent	27.3	29.5	40.5
Eurodif	diffusion	10.8	10.8	10.8
Urenco	centrifuge	1	2	2+
Soviet Union (for export)	diffusion	3	2-3	2-3
Japan	centrifuge	0.05	0.2	1-2
South Africa	helicon	0.03	0.3	0.3
Brazil	jet-nozzle	—	0.1	0.3
Australia	centrifuge	—	—	1
TOTAL		42	45-46	58+

In fiscal year 1983, the **US DOE** diffusion plants produced about 12 million SWUs, and DOE sold about 14.2 million SWUs. The difference was made up by drawing down a stockpile of enrichment that had been accumulated in earlier years. About 12 million SWUs in excess of what is needed for a working inventory remains in the DOE stockpile.

In addition to the existing diffusion plants, DOE is building a new plant near Portsmouth, Ohio, which is designed to use a gas centrifuge process. The Gas Centrifuge Enrichment Plant (GCEP) is scheduled to begin partial operation in 1988 and reach its current design capacity of 13.2 million SWUs per year in 1994.

DOE is also developing advanced centrifuges capable of being installed in the GCEP plant, with the goal of doubling the capacity of that plant. In addition, DOE is developing a laser isotope separation technique which its proponents believe may provide the lowest cost enrichment in the 1990s.

Eurodif owns and operates a single enrichment plant at Tricastin, France. The plant, which uses the diffusion process, began operation in 1978. The Tricastin plant has the capacity to produce 10.8 million SWUs per year. However, only 5.5 million SWUs were produced and sold between October 1982 and October 1983.

Urenco centrifuge enrichment plants with capacities of about 0.4-0.6 million SWUs per year are operating at Almelo in the Netherlands and at Capenhurst in England. Urenco plans eventually to increase the capacity of each of those plants to one million SWUs per year, and is building an additional one million SWUs per year centrifuge enrichment plant at Gronau in West Germany. Between October 1982 and October 1983, Urenco produced about 0.6-0.8 million SWUs.

The **Soviet Union,** through its marketing agent Techsnabexport, currently holds contracts for the export of between two and three million SWU per year. Most of its exports are under long-term contracts executed during the 1970s with countries which now have interests in Eurodif or Urenco. Customers in those countries could stop purchasing enrichment from the Soviets in favor of their domestic suppliers when their contracts expire in the early 1990s. The Soviets price their enrichment at five percent below the US price.

There are currently 30 million **excess SWUs** held by enrichment customers in the USA and abroad. About one-half of those SWUs were originally produced and sold by DOE and the rest are of foreign origin. The size of the secondary market for the next few years will depend upon the price and contracting terms that the primary enrichment suppliers offer and the pressure on utilities to sell off their excess SWUs. About 5.4 million SWUs were traded on the secondary market in FY83.

Demand

World enrichment demand is estimated to increase from a current level of about 16 million SWU per year to 36 million SWUs per year in 1995, as shown in Table 11.

Table 11

PROJECTED ENRICHMENT DEMAND[1] (millions of SWUs)

Year	Enrichment Demand
1983	16.3
1985	22.0
1990	30.1
1995	35.7

[1]Uses conversion factor of 0.112 million SWUs per gigawatt of installed stalled capacity using enriched uranium. (That conversion factor is an average value from DOE's Dec. 1982 yearly nuclear powerplant capacity and enrichment demand projections for the United States from 1984-2000. The yearly conversion factors vary from 0.095 to 0.122 because of the different SWU requirements of new reactors and those in equilibrium.)

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FY83 SWU sales by primary enrichment producers alone were about 23.4 million SWUs—14.2 million by DOE, 5.5 million by Eurodif, 3 million by the Soviet Union, and about 0.7 million by Urenco. Hence, enrichment supply exceeded the demand by over seven million SWUs in 1983—and that in a year in which DOE and Eurodif operated their enrichment plants at little more than half of their full capacity. In conclusion:

1. The existing production capacity of the Department of Energy, Eurodif, and Urenco alone is sufficient to meet projected world demand in 1995.
2. If all the enrichment capacity planned for 1995 is completed, it would exceed the projected world demand in that year by more than 60 percent.

US Market Share

The demand for enrichment supplied by the USA will depend upon US marketing efforts, as well as other factors. Instead of estimating what the US market share will be, I have calculated the maximum and minimum demand levels that the United States might satisfy through 1995 based on externally imposed market limits.

For the maximum level, I have assumed that the US would supply the entire projected enrichment needs of all countries except those that have shares in Eurodif or Urenco and four countries which are currently excluded from US sales for non-proliferation reasons. At the other extreme, for the minimum level, I have assumed that the United States supplies only the demand remaining after all other suppliers sell all of the enrichment they can produce.

What I found was that the difference between the minimum and maximum US enrichment markets is quite small in 1990 and 1995 when one considers the extremely different assumptions by which they were estimated—In 1995, I estimate the minimum US enrichment market to be 18.3 million SWUs and the maximum to be 23.7 million SWUs. It is instructive to compare such estimates with the latest available Department of Energy projections of enrichments services to be supplied by DOE through 1995.

The Department of Energy's December 1982 country-by-country estimate of the nuclear power capacity most likely to be supplied with enrichment services by the United States in 1985, 1990, and 1995 is shown in Table 12. That estimate was predominantly based upon current enrichment supply contracts held by DOE and anticipated extensions of those contracts. DOE also included a small number of new contracts and contract cancellations.

Table 12

"MOST LIKELY" NUCLEAR POWERPLANT CAPACITY TO BE SUPPLIED WITH ENRICHMENT SERVICES BY US DOE
(Gwe in operation at end of year)

Country	1985	1990	1995
France	1.9	0.0	0.0
Fed. Rep. of Germany	5.0	4.6	3.9
Japan	17.2	23.4	39.9
Korea	2.1	4.8	4.3
Mexico	0.0	1.3	1.9
Netherlands	0.4	0.4	0.4
Philippines	0.0	0.6	0.6
Spain	6.0	6.9	6.9
Sweden	7.4	8.4	8.4
Switzerland	2.5	1.6	1.6
Taiwan	4.0	4.9	4.9
Yugoslavia	0.6	0.6	1.6
TOTAL NON-US	47.1	57.5	74.3
United States	86.2	117.7	122.4
TOTAL CAPACITY	133.3	175.2	196.7
TOTAL SWUs (millions)	14.8	19.3	22.3

The DOE estimate means the Department expects to supply enrichment services to 100 percent of the US nuclear power capacity in operation through 1995, 43 percent of foreign capacity in operation in 1985, and 37 percent of foreign capacity in operation in 1990 and 1995.

The maximum enrichment market available to the United States may be estimated by assuming that all Western customers other than members of Eurodif and Urenco buy all of their enrichment from the United States. Under that assumption, we estimate that the maximum market for United States enrichment services is an additional 10.1 GWe in 1985, 18.7 GWe in 1990, and 23.8 GWe in 1995 above the DOE estimate. This maximum available market is only about a ten percent increase over DOE's most likely estimate in each of those years. Given the vigorous competition from foreign enrichment suppliers and the secondary market, the DOE December 1982 estimate may be too optimistic.

One may conclude from this that the US share of the world enrichment market in the early 1990s is relatively insensitive to whether the Department of Energy attempts to maximize its sales or is content to meet only the demand that its competitors cannot satisfy. That

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finding differs from what is found for both the short-term and longer-term. In the short term, the large excess enrichment supply and private stockpiles threaten a substantial portion of the current DOE market. United States enrichment sales may vary greatly depending upon DOE pricing and marketing practices.

Government Goals for a US Enrichment Enterprise

After discussions with a range of people interested in enrichment, I was able to identify four broad goals which appear to be widely accepted.

1. Assure an adequate long-term supply of enriched uranium for domestic utilities and defense purposes.
2. Minimize the cost to consumers of enrichment services.
3. Support nuclear weapons non-prolieration objectives.
4. Avoid any net federal spending on enrichment.

In the long term, these goals may all be satisfied by a market strategy aimed near the middle of the projected maximum and minimum demand levels for US enrichment. This may be a better strategy than attempting to maximize the US market share, because such a strategy increases the chances of matching supply and demand, which, given the capital intensive nature of the enrichment enterprise, is important for holding down enrichment costs.

In the short term, it may be difficult to satisfy all four goals with any market strategy. The cost of enrichment to consumers could be reduced in the short-term if DOE were to release customers from contractual obligations and allow them to purchase lower-priced enrichment on the secondary market or from foreign suppliers. However, that would result in smaller revenues for DOE, which under current funding arrangements for DOE's enrichment activities could make it difficult to finance modernization of enrichment production capacity without sizable net government appropriations.

On the other hand, if DOE retains a large share of the short-term enrichment market, the revenues might be sufficient to finance development and construction of new capacity. This approach could require either holding customers to contracts that do not allow them to minimize costs (sacrificing goal 2) or reducing DOE prices and possibly not recovering the full government cost of enrichment (sacrificing goal 4).

It would appear that if the goals of minimizing the cost of enrichment to consumers and avoiding net federal spending on enrichment are both to be maintained, it may be necessary to slow the pace of development and construction of new enrichment capacity considerably or find an alternate means of financing those activities.

Thank you for your interest and attention. I hope my remarks will be of assistance to the committee. I will try to answer any questions you may have. However, I must remind you that as a CRS witness I must refrain from advocating positions on policy decisions facing the Congress.

TESTIMONY OF THOMAS B. COCHRAN AND JEFFREY I. SANDS

Natural Resources Defense Council

This testimony addresses two questions: first, the nuclear weapons proliferation risks associated with development of Advanced Isotope Separation (AIS) processes, and, second, the advisability of proceeding with Phase II of the Set III GCEP machine procurement contracts to be let this fiscal year.

Nuclear Weapons Proliferation Implications

We endorse the finding regarding proliferation considerations of AIS technologies of the ERAB Study Group's 1980 Report on Advanced Isotope Separation, and the report's conclusion that proliferation risks should be treated as a central design problem for the processes.

The greatest proliferation risk associated with federal AIS development is DOE's plan to employ Pu-LIS to enrich 10-15 tons of fuel-grade plutonium in the existing DOE stockpile, including plutonium derived from or currently used in civil R&D reactors, for its use in the weapons program. This DOE plan is not prohibited by law due to a loophole in the Hart-Simpson-Mitchell Amendment to the Atomic Energy Act (Section 57, PE). It violates, however, the spirit of the NPT presumption against the use of civilian nuclear technology for military purposes and undermines the bed-rock foundation of US non-proliferation policies that a clear distinction can be justified on the basis of either economics or national security, and we urge the committee to support efforts to

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close this loophole. DOE has also failed to prepare a programmatic Environmental Impact Statement (EIS) for Pu-LIS as required by NEPA, and we urge this committee to demand that DOE comply with the NEPA requirement.

DOE's work on the Plasma Separation Process (PSP), also being funded under DOE's Defense Programs budget, has significant nuclear weapons proliferation implications. PSP could significantly increase the proliferation hazard of worldwide uranium enrichment activities due to its modular design, established technology and hardware, and smaller size. The technology has not been demonstrated. Due to PSP's proliferation potential, it is questionable whether this program should be continued.

Phase II Set III Machine Procurement

The US has a huge excess in uranium enrichment capacity with the three existing gaseous diffusion plants, and the current market situation does not compel us to add new Set III capacity in order to meet demand until the early 1990s when AGC and AVLIS technologies will be fully developed. Since a decision between construction of AGC or AVLIS capacity cannot be made at this time, a decision to build process buildings beyond the first two at GCEP, already committed, should be deferred until the 1986-1987 AGC vs. AVLIS competition is complete.

We see no economic advantage in Phase II Set III machine procurement and deployment over continued operation of GDP capacity. In fact, there very well could be a significant economic *penalty* associated with continuing Phase II Set III procurement activities. We therefore urge this committee to ask DOE to cancel or minimize the procurement of Set III machines via Phase II contracts to the lowest possible level consistent with retaining a capability to deploy AGC (Set V) in a timely manner.

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